March 2018

Improving Science Communication in Wellington: An analysis of public knowledge of sea level rise in the Central Business District of Wellington, New Zealand

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Improving Science Communication in Wellington:

An analysis of public knowledge of sea level rise in the Central Business District of Wellington, New Zealand

An Interactive Qualifying Project Report submitted to the Faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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March 2, 2018

Abstract

The goal of our project was to assess public perceptions of sea level rise in Wellington in order to provide recommendations to our sponsor, the Antarctic Research Center of Victoria University, for developing outreach initiatives to communicate their research to the public. Using convenience surveys administered to the pubic and expert interviews administered to science communication experts and local public officials, we found three areas to target for future outreach and five practices to communicate them effectively. Our recommendations for potential outreach strategies ranged from computer simulations to art installations.

Executive Summary

The Issue

Sea Level Rise (SLR) is a worldwide issue and a direct consequence of global climate change that poses great risk to coastal communities. In the past 80 years, global sea level has risen at a rate of approximately 3 millimeters per year, resulting in a total rise of approximately 100-200 millimeters in the past century (National Geographic, 2017). Additionally, experts have estimated that by 2100, sea level could rise up to another 2 meters based on current projections (Thead, 2016). A rise in sea level at that rate has the potential to severely impact coastal communities all over the world.

Many of the world's largest cities and economic centers are located in coastal areas, and residents, workers, and assets in those areas are directly endangered by SLR. This is a risk of particular concern in New Zealand, where three of the country's largest cities by population - Auckland, Wellington, and Christchurch - are all located on the coast, and account for 42% of the country's total population (New Zealand Census 2016). With such a large percent of the population in these regions, SLR poses a threat to the economic, social and the environmental stability of the country. Due to the high risk and dire consequences, it is imperative that the New Zealand public become educated about climate change and sea level rise so that they can make informed decisions for the future of their country.

Our sponsor, the Antarctic Research Centre (ARC), headquartered in the Victoria University of Wellington, is a research organization that contributes climate change and sea level rise data and knowledge to the scientific community. Their expertise lies in scientific research in glaciology, particularly in studying sediment and ice cores in order to make predictions and models for future global climates and resulting sea level rise. As the dangers of sea level rise become more apparent through their research, it is increasingly imperative for research groups such as the ARC to be able to effectively communicate their research to the public. The ARC is seeking to improve their communication with the public through a more robust public outreach strategy.

Our Approach

The goal of this project was to assess the public's perceptions of SLR in Wellington in order to provide recommendations to our sponsor, the Antarctic Research Centre, for devel-

oping outreach initiatives to communicate their SLR research to the public. To accomplish this goal, we developed three primary objectives. These are described below in the project organization diagram, Figure A.

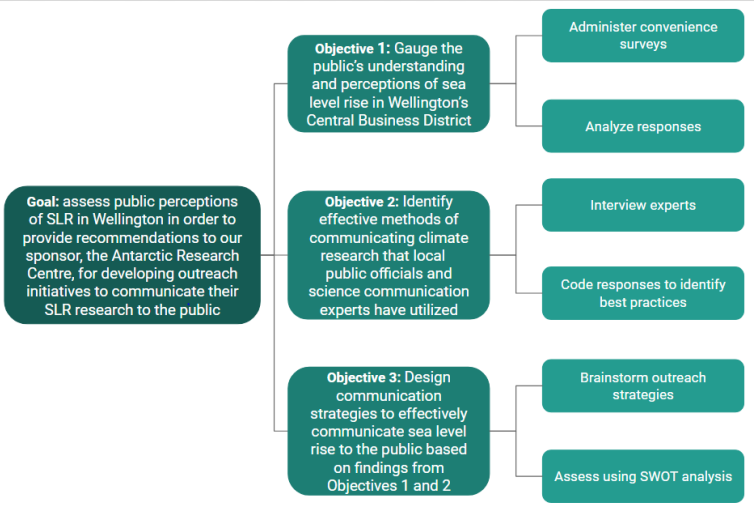

Figure A: Project Organization Diagram

Objective 1: Gauge the public's understanding and perceptions of sea level rise in Wellington's Central Business District

In order to determine the public's understanding and perceptions of sea level rise, we administered convenience surveys in the Central Business District (CBD). Our survey questions focused on four main pieces of knowledge that we wanted to gather: general SLR knowledge, perceived spatial risks of SLR, perceived temporal risks of SLR, and perceived comparative risks between SLR and other natural disasters, in addition to some demographic information.

We administered 153 surveys in total at several locations around the CBD. We analyzed the responses from these surveys through coding, cross-tabulation, and statistical analysis such as quartile analysis. To complete our analysis, we compared question responses against demographic data as well as against other responses. This allowed us to triangulate findings across several of the knowledge types that we identified. Through this, we were able to visually analyze all of our data in order to determine the presence of significant patterns. Once we had identified several patterns, we then used psychological frameworks and cognitive heuristics to try to explain their significance.

Objective 2: Identify effective methods of communicating climate research that local public officials and science communication experts have utilized

In order to learn more about how climate science had been communicated in Wellington in the past, we held interviews with local public officials and science communication experts.

In these interviews, we asked about each interviewee's experiences, as well as their role, in science communication in both the Wellington region and New Zealand. Each interview was tailored to the interviewee's experience but used similar questions to gather similar information.

After administering seven interviews, we then transcribed and coded each for recurring themes. Similar to our first objective, we then used psychological frameworks and cognitive heuristics to try to verify and provide further insight into the recurring themes. These themes that emerged were identified as best practices for communicating science research in Wellington.

Objective 3 (Recommendations): Design communication strategies to effectively communicate sea level rise to the public based on findings from Objectives 1 and 2

After learning about the public's knowledge of SLR and best practices of science communication in Objectives 1 and 2, we then brainstormed potential outreach strategies to recommend to the ARC. The team used an iterative brainstorming strategy to develop 50 potential strategies. The list of 50 ideas was then narrowed and organized into several categories through clustering in order to develop detailed, robust strategies. This resulted in four potential outreach strategies: website, social media, simulation, and art installation. Lastly, we implemented SWOT analysis to assess each strategy's potential effectiveness. We created detailed plans for each of these four ideas and presented them to the ARC as our recommendations.

Our Findings

Objective 1:

Through our public surveys, we identified three significant findings: the public does not feel prepared to respond to sea level rise, the public's knowledge of sea level rise is incomplete, and the public mainly uses the internet to learn about sea level rise.

Preparedness vs Risk: The first interesting finding we made through our survey responses was that there exists a disparity between the public's perceived risk and preparedness for sea level rise. One of our survey questions asked respondents to rate how at risk and prepared they felt for four different risk events: earthquakes, tsunamis, storm surge, and sea level rise. Through analyzing this question and corroborating with other questions, we were able to determine that there is a gap between public's perceived risk and preparedness for sea level rise that is much larger than that of the other risk events. This is represented in the quartile analysis in Figure B. This made it evident that although the public feels at risk to sea level rise, they do not feel prepared to respond. This data also indicated to the team that it is important that our communication strategies convey methods that the public can use to become more prepared.

Incomplete Knowledge: The second interesting finding that we identified was that the public has a basic, but not detailed, knowledge of sea level rise. This was supported

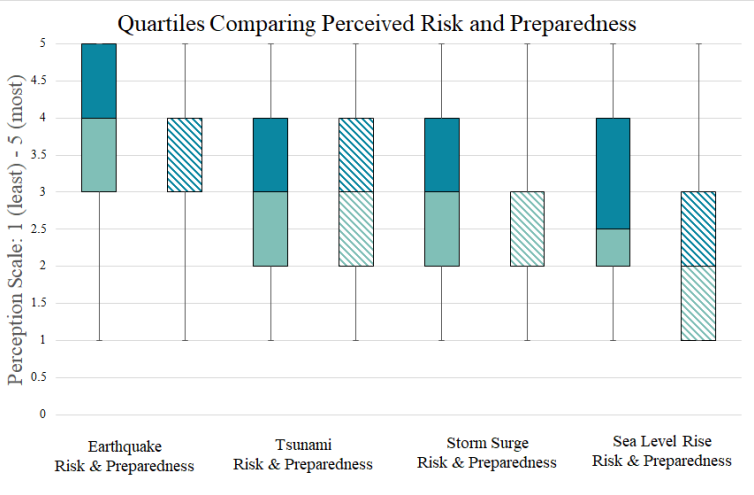

Figure B: Risk Preparedness Quartile Comparison (n = 153)

by several of our survey questions which each looked at different metrics for understanding SLR. For example, one question looked for a self-assessment of understanding while others looked at the ability to identify causes and factual information about SLR. The result from analyzing these questions was that the public has a partial understanding of sea level rise and its impacts, but their understanding is not complete. This indicated to the team that it is important that our outreach strategies include some educational aspect to inform people about sea level rise.

Information Sources: The team also identified through our surveys that, not surprisingly, the public finds the majority of their information about SLR on the internet. One open-response question asked respondents to report the main sources they use to learn about sea level rise. To this question, 54% of respondents cited the internet. The next closest category was TV, which included documentaries and broadcast news, which accounted for another 38%. This finding informed the team that an internet-based outreach approach would likely have the highest chance of being successful.

Objective 2:

There were five main takeaways from these interviews: making information easy to understand, trust, framing conclusions, positive versus negative messaging, and communicating uncertainty.

Information Simplicity: In order to let people retain the information they are presented, they need to be able to understand what is being said to them. Making information easily consumable has three main facets. The first is communicating in non-technical language whenever possible, so the public will have a greater likelihood of understanding. Also, it is important to communicate in several formats in order to accommodate many different kinds of learners, such as auditory, visual, and tactile. The final aspect from this finding is to make science communication interactive whenever possible, because providing a social experience increases information retention.

Trust: People need to trust an information source before they will believe any of the

information they are given from that source. Trust can be built in many ways, and the primary method identified is through name recognition. Another way to build trust is to make the science as well as the scientists more relatable. When the public builds a personal connection with a researcher, they are more likely to trust them.

Drawing Conclusions: To improve information retention, experts identified that it is important to allow the target audience to come to the conclusion by themselves. When communicating science it is important to present the facts in a way that leads the public to the conclusion you are seeking to make, without feeding them that specific conclusion. This allows the audience to have their own realization of the conclusion through an "a-ha" moment, and they will be more likely to remember the conclusion they made.

Positive Messaging: Presenting a situation negatively has the potential to leave the reader feeling distressed and hopeless, as if their contributions would not make a difference to the eventual outcome. Positive messaging on the other hand presents the facts and shows that the situation can be bad, but can also leaves the audience feeling hopeful and empowered, and wanting to take action. Especially in regards to sea level rise, positive messaging is much more impactful.

Uncertainty: While scientists use the term as a probabilistic measure of error, the public perceives it as having a lack of confidence. Therefore, when scientists communicate about uncertainty, the public perceives it with a very negative, unsure connotation. Instead of using the word "uncertain", it is important that climate researchers use a different word like "variability" or describe levels of "robustness" in data, which communicates the same range of possible scenarios but without the negative connotation.

Recommendations

SLR Simulation: Our first recommendation to the ARC is to create an online sea level rise simulator. This simulation would allow users to explore different climate change scenarios, visualize different contributors to SLR, and model potential effects of SLR such as loss of coastal land and increased frequency of severe floods. The goal of this outreach strategy would be to allow the user to better understand the concept of uncertainty as well as to allow them to make their own conclusion about how SLR will affect them through interacting with the simulation.

Social Media Campaign: We are recommending that the ARC begin a three-pronged campaign including a Facebook page, a short series of YouTube videos, and an Instagram account because many people use social media as a source of information. The main purpose of the Facebook page would be to increase ARC name recognition and give them the ability to share important publications or local climate change-related events. The YouTube series would be a short series of videos to explain in simple terms what sea level rise is, how it affects New Zealand, and how people in New Zealand can prepare for it. Finally, the main purpose of the Instagram would be to increase trust and relatability to the public by posting researcher biographies and expedition updates. Through this three-pronged approach, the ARC would be able to provide easily consumable information as well as build trust with the public.

Website: The goal of the website is to provide a single location for the public to access

all of the information concerning SLR. Keeping all the information about SLR in one location creates a single resource for people to expand their understanding. A website would also present people with resources on response strategies for SLR to help them better understand what they can do as individuals and as a community. The website could include tabs on explaining what SLR is, what the impacts are on New Zealand, and how the public can respond to mitigate its effects. Additionally, the website is synergistic with the other recommendations discussed. The website would link to the SLR simulation and the social media campaign could also increase traffic to the website.

Art Installation: The goal of an art installation would be to evoke an emotional response from the public and motivate them to want to take action. One idea we discussed was creating a set of human-sized water bottles that would be appeared to be filled with liquid up to the projected rise in sea level for different IPCC scenarios. A sign would accompany this installation that would explain what each sea level projection would mean for its impact on New Zealand, how human action lead to this projection and provide a resource for the public to learn more about SLR.

Acknowledgements

We would like to thank several individuals that made this project possible, namely:

- Dr. Shaun Eaves, Jamey Stutz, and Ross Whitmore, for their support and encouragement.
- Professors Michael Elmes and Carolina Ruiz, for their devotion to our success and guidance throughout the IQP process.
- Dr. Tim Naish, for his help and expertise.
- Our expert interviewees, for taking time to meet with us.
- Professor Stephen McCauley, for his instruction and supervision during the preparation for this project.
- The Antarctic Research Centre, for providing the opportunity for us to work on this project.

Acronyms

AIS	Antarctic Ice Sheet
ARC	Antarctic Research Centre
ASAP	As Soon As Possible
CBD	Central Business District
CCT	Cultural Cognition Thesis
CO2	Carbon Dioxide
DoC	Department of Conservation
GDP	Gross Domestic Product
GNS	Institute of Geological and Nuclear Sciences
GWRC	Greater Wellington Regional Council
IPCC	Intergovernmental Panel on Climate Change
LIDAR	Light Detection And Ranging
NIWA	National Institute of Water and Atmospheric Research
NOAA	National Oceanic and Atmospheric Administration
NZ	New Zealand
NZD	New Zealand Dollar
RCP	Representative Concentration Pathways
SLR	Sea Level Rise
SWOT	Strengths Weaknesses Opportunities and Threats
UK	United Kingdom
USA	United States of America
USD	United States Dollar
VUW	Victoria University of Wellington
WCC	Wellington City Council
WPI	Worcester Polytechnic Institute

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Chapter 1

Introduction

Sea Level Rise (SLR) is a worldwide issue and a direct consequence of global climate change that poses great risk to coastal communities. In the past 80 years, global sea level has risen at a rate of approximately 3 millimeters per year, resulting in a total rise of approximately 100-200 millimeters in the past century (National Geographic, 2017). Additionally, experts estimated that by 2100, sea level could rise up to another 2 meters based on current projections (Thead, 2016). Many of the world's largest cities and economic centers are located in coastal areas, and therefore their residents, workers, and assets are directly endangered by SLR.

Wellington is one such city that is particularly at risk to sea level rise due to its geographic location. The city is located directly on Wellington Harbor and it contains over $6.5 billion New Zealand Dollars (NZD) in assets that are located within a 1.5 meter elevation above sea level (Reinen-Hamil et al., 2013). Additionally, Wellington sits between three active fault lines, which makes the city susceptible to earthquakes and tsunamis, the effects of which will be exacerbated by a particularly high sea level. The Central Business District (CBD) is a small area of the city located on Wellington Harbor which is particularly at risk to SLR because it is the economic and political hub of Wellington. The CBD economically supports 200,000 citizens and houses the governing body of the city and the country, making it an area of great concern in regards to sea level rise.

Our sponsor, the Antarctic Research Centre (ARC), headquartered in the Victoria Uni-

versity of Wellington, is a research organization that focuses on studying climate change and sea level rise. Their expertise lies in scientific research in glaciology, particularly in studying sediment and ice cores in order to make predictions and models for future global climates and resultant sea level rise. Organizations such as the ARC are crucial in the effort to combat sea level rise because they perform the critical research that aids society's understanding of the dangers of SLR. As these dangers become more apparent, it is increasingly imperative for research groups such as the ARC to be able to effectively communicate their research to the public. This is because when the public is well-informed about sea level rise, they can more effectively contribute to the sea level rise discussion and help to mitigate it.

The ARC has had an outreach strategy in place for about 15 years. During this time, they have attempted to employ several different outreach methods, including holding public lecture series, facilitating radio and TV interviews, and attending elementary school show-and-tell events, all with varying levels of success. The ARC has sought to employ better methods of public outreach in order to more effectively share their research with the Wellington public. However, as a primarily research organization, their main focus is on producing cutting-edge research publications, and they have comparatively few resources to develop a means of communicating with the public on their own. Our goal was to assess the Wellington public's understanding and perceptions of sea level rise in order to make recommendations to improve the Antarctic Research Centre's public science communication methods. To achieve this, we separated our project goal into three objectives. First, we sought to gauge the public's understanding and perceptions of sea level rise in the Central Business District (CBD) by administering convenience surveys. Next, we generated a list of best practices by interviewing local public officials and communication experts to learn from their experiences in science communication. Finally, in our third objective, we used the findings from objectives one and two to develop improved communication methods for the ARC through an iterative design process. Together, these three objectives guided our team to recommend methods for the ARC to improve their science communication to the public.

Chapter 2

Background

Coastal communities around the world are being threatened by sea level rise (SLR) at an increasing rate. Therefore, society must explore better methods to communicate to the public about the risk SLR poses to coastal communities and how these communities can respond. In this chapter, we discuss the widespread impacts of sea level rise globally and in New Zealand, the research that the Antarctic Research Centre contributes to the scientific community, the concept of science communication, and the psychological frameworks that underlie science communication.

2.1 Sea Level Rise as a Global Issue

Sea level rise is a global phenomenon that is defined as the increase in the height of the ocean's surface irrespective of changing tides (National Geographic, 2017). Coastal tide gauges from around the world indicate that the average global sea level has risen by 3 mm/yr over the last 20 years and 1.5 mm/yr in the 60 years prior for a total rise of 20 cm in the last 80 years (National Geographic, 2017). This trend indicates that the rate of sea level rise is accelerating and recent climate models take this into account with the sea level projected to rise by 30-50 cm in the next 30 years and 80-200 cm in the next 80 (Thead, 2016). A rise in sea level of this magnitude has the potential to destroy oceanside cities, challenge coastal

ecosystems, and displace millions of people worldwide.

Sea level rise is one of the measurable impacts from human induced climate change. Human induced climate change, specifically global warming, is attributed to the accumulation of greenhouse gases in the atmosphere post industrial revolution and the increase in the earth's albedo. Albedo is the amount of energy that is absorbed by the planet as opposed to reflected back into space (NASA, 2018). An increased albedo means more of the sun's energy is absorbed into the earth's surface, which increases the temperature of the planet (NASA, 2018). Greenhouse gases such as carbon dioxide and methane trap energy reflected by the earth in the atmosphere which forms a warmer blanket of air around the planet and also increases the Earth's average global temperature. These two phenomena cause ice sheets and glaciers to melt. The water released from landlocked ice is a large contributor to global sea level rise (National Geographic, 2017). Additionally, the increase in average global temperatures also causes thermal expansion of the oceans. Thermal expansion is a concept that explains how an increase in temperature causes a decrease in density (National Geographic, 2017). Therefore, the same mass of ocean would occupy more volume, leading to an increased ocean height (National Geographic, 2017). Thermal expansion and the loss of landlocked ice sheets are the main causes of sea level rise as result of human induced global temperature rise.

2.2 Sea Level Rise as a Global Issue

Sea level rise poses an immense threat to humanity and global ecosystems alike. Data logging from Goddard Space Flight Center shows that the oceans have risen by about 6 centimeters since 1993 (Becklety et al., 2015). Additionally, sea level is also projected to rise by somewhere between 80 and 200 centimeters over the next 80 years. Such an increase has the potential to cause massive amounts damage to property and the environment. In particular, coastal cities are at risk of losing large amounts of infrastructure, including utilities, commer-

cial and residential buildings, which could potentially cause the mass migration away from the coast. Aside from the loss of land mass for coastal communities, SLR could also cause an assortment of environmental damages such as the destruction of coastal ecosystems, erosion, soil contamination, and the displacement of animals' habitats. This section will discuss in detail some of the most severe impacts that sea level rise will have on New Zealand.

2.2.1 Environmental Impacts

An increased sea level poses iminent problems for New Zealand's environment. Erosion and loss of land are some of the most serious concerns of sea level rise in New Zealand. Some main topics of concern include the submergence and increased flooding of coastal land, as well as saltwater intrusion into freshwater aquifers (Nicholls & Cazenave, 2010). This is a main concern because once sea level rise has begun, flooded land cannot be reclaimed. Additionally, as New Zealand is an island which contains over 15,000km of coastline (Bell & Gibb, 1997), it is at a particularly high risk to experience devastating land loss.

This severe loss of coastal land corresponds directly with widespread loss of habitat for many species, particularly in wetland areas. Mander (2007) noted, "As sea level rises, coastal habitats are inundated, eroded, or washed away which can result in habitat lost and in turn cause a decline in the populations of shoreline dependent organisms". Aquatic plants, fish, and shoreline-dependent birds are just a few of the groups that are at risk to lose their natural habitats as a result of sea level rise. Shoreline-dependent birds are at a particularly high risk because coastal areas are imperative to their nesting and foraging (Fuji & Raffaelli, 2008). In fact, the value of wetlands worldwide that are at high risk to be damaged by sea level rise was estimated at $630 million in US dollars (USD) in the year 2000 (Blankespoor et al., 2012). Therefore, as wetlands are lost to sea level rise, it will create a loss of habitat for many species as well as a large economic loss. New Zealand is home to over 80 species of shoreline birds, one third of which are endemic to the country (New Zealand Department of Conservation, 2010), and sea level rise directly threatens all of them.

Sea level rise is also expected to have a devastating impact on soil and aquifer health worldwide due to saltwater intrusion. Saltwater intrusion is the process of rising levels of salt water impacting the purity of aquifers (Werner & Simmons, 2009). This water contamination is also a concern for agricultural soil health. Soil contaminated with seawater will poison agricultural crops and has the potential to destroy harvests. One example of water contamination occurred in a village in the Satkhira district of Bangladesh. Due to unavailability of freshwater combined with soil degradation due to saltwater intrusion, this area has seen markedly lower yield in their rice crops, in fact, Satkhira's output in 2003 was only 69% of what it had been in 1985 (Sarwar, 2005). This is supported by a World Bank study which claimed that increased salinity alone from a 0.3 meter sea level rise will cause a net reduction of 0.5 million metric tons of rice production in Bangladesh (World Bank, 2000). SLR increases will affect more agricultural land worldwide and reduce crop productivity, raising food prices and increasing food scarcity. Many crops are grown in New Zealand such as grains, fruits, and nuts, which would all be endangered by saltwater intrusion caused by sea level rise.

Another critical environmental concern related to sea level rise is inclement weather. When sea levels rise, the severity of natural disasters increases by raising the height of waves, and increase the frequency of flooding from storm surges. These factors are combined in the term 'storm inundation', which is defined by the New Zealand Ministry for the Environment in their Preparing for Coastal Change (2009) fact sheet series as "A natural event arising from extreme weather events (storms), in which normally dry, but low-lying coastal land is flooded." Storm inundation can lead to breached coastal barriers, like natural gravel ridges or human-made stop banks, which put residents at extreme risk to severe flooding. With higher sea level, storm inundation is more likely to be worse and more prone to cause long-term damage. The Ministry for the Environment recognized this causality in the same Preparing for Coastal Change (2009) fact sheet by writing, "Inundation has a dramatic effect on vegetation and pasture production, and can sometimes curtail pasture growth for a

year or more." Furthermore, Dr. Timothy Naish, former director of the Antarctic Research Center (ARC), has stated that with 1 meter of sea level rise, the 1-in-100 year storm may become an annual event. It is clear by all of the above mentioned effects that sea level rise can have widespread environmental effects on areas that can reach far beyond the coastline.

2.2.2 Economic Impacts of Sea Level Rise in Coastal Areas

Estimating the economic impacts of sea level rise is extremely difficult because SLR has such wide-reaching effects. In 2015, Valentine observed, "the number of elements which confound the predictive accuracy of SLR economic impact assessments is staggering". In general, there are three basic elements of an economic impact assessment for sea level rise: predicting severity of sea level rise over the next century, assessing consequences of sea level rise, and estimating costs (Valentine, 2015). Each of these elements contains a high degree of uncertainty, as the rate of sea level rise is hard to predict with precision for the future. The consequences of sea level rise are also unknown because cost is driven by a wide variety of treatment options which vary from taking no action to rebuilding a city around the incoming water (Sahin et al., 2013). However, making these assessments is still necessary, and they are made to be as accurate as possible, because economic impact studies play an important role in many policy decisions (Valentine, 2015).

In a study by Pycroft and colleagues (2016), the authors used satellite imaging to assess land usage in 84 developing countries, and concluded that in those countries, approximately 2% of GDP and population would be endangered by a 2 meter sea level rise (2016). Additionally, in a 2015 study by Joshi, Vielle, Babonneau, Edwards, and Holden, it was estimated that total urban land loss due to sea level rise in Australia and New Zealand could be between 798 and 2205 km2 by 2100 (Joshi et al., 2015). This study concluded that New Zealand, as well as Australia, Latin America, Western Europe, and the United States were among the countries that would experience the most detrimental effects to their coastal urban areas, and they estimated that total urban losses for all countries would exceed $100 billion USD.

In fact, three of New Zealand's largest cities by population - Auckland, Wellington, and Christchurch - are all located on the coast. These three metropolitan areas have a combined population of over 2 million people, which represents approximately 43% of New Zealand's total population, according to 2016 Census data.

Because climate change mitigation efforts cannot slow SLR immediately, adaptation is now seen as a necessary approach to manage rising waters in coastal cities. Adaptation is a response to some aspects of climate change that reduces its effects in an area. It is beneficial because it can be performed on a local scale and does not require cooperation from many countries in order to be effective. There are three main adaptation techniques: retreat, accommodation, or protection (Sahin et al., 2013). Retreat is the toughest technique to implement, especially for large, well developed cities that would be forced to abandon expensive coastal infrastructure (Fu & Song, 2017). For this reason, protection and accommodation are the preferred methods. Protection techniques involve the construction of seawalls and artificial barriers. An example of this is the Thames Barrier in London, which is a series of hydraulic gates that sit underwater and can be raised or lowered in order to protect London during high tides (Tol, Klein, & Nicholls, 2008). Accommodation techniques involve reshaping section of a city around the intruding water: this means building channels and creating other modifications within the city to facilitate the disbursement of water. Protection and accommodation techniques cost about the same to implement, however, to maintain a low-cost implementation significant planning is required, which may reduce its operation range (Tol, Klein, & Nicholls, 2008).

2.2.3 Social impacts

Another major impact of sea level rise is displacement of people from coastal areas. In a 2016 study (p. 814), Joshi, Vielle, Banonneau, Edwards, and Holden noted that, "With nearly two-fifths of the world population living in coastal zones, flooding from SLR and storm surges has the potential to prompt large-scale migration of human populations, together with

political instability, and could cause devastating loss of homes, businesses, infrastructures, and coastal shallow-water ecosystems." Additionally, they estimated that between 5.1 and 15.9 billion people in these countries would be displaced by sea level rise by 2100 (Joshi et al., 2016) The 2011 UK Foresight report predicts that this displacement of people will be made worse by a net migration of the populace towards coastal areas that are more vulnerable to sea level rise. This study projected that approximately 200 million more people will be living in urban coastal floodplains in Africa and Asia by 2060, through a combination of natural population expansion coupled with continued migration from rural to urban areas (UK Government Office for Science, 2011). This movement will likely exacerbate the process of accommodating SLR in large coastal cities. Additionally, the negative social impacts of SLR will likely be made worse when the coastal devastation begins to affect economic transactions inland, such as the reduction in crop yield from salt water intrusion leading to food shortages.

Hallegatte proposed in 2012 that SLR will cause severe political instability. In her research, she reported that the citizens on the coast would experience the worst of SLR, and would therefore require additional financial support from the government. However, she warned that, "This could create political and social tensions since policies would have large redistributive effects: if large investments are made, the rest of the population can see them as inappropriate; if necessary investments are not made, the population at risk may feel unprotected by its government" (Hallegatte, 2012). Hallegatte claims that the resulting political tensions would likely make it difficult for the country to recover and adapt to SLR.

Severe SLR could also potentially cause mass migrations inland towards safer, more protected environments. Black et al. (2012) noted that, "migrations have multiple interacting drivers, and that economic activity and income only represent one component of the migration decision, in addition to other social, cultural, demographic and political drivers". However, economic growth is a large driver in terms of SLR because so many industries are put at risk by rising seas. Hallegatte (2012) argues that, "lower growth can lead to

crisis, unemployment and lower income, which are often followed by out-migration" (2012). Migrations are a natural societal response to economic crises and volatility, and it is likely that SLR could provide sufficient economic and environmental instability to cause citizens of coastal areas to migrate. The 2011 UK report on Migration and Global Environment Change claimed, "The underlying driver of migration to cities has been identified as uneven spatial economic development, specifically inequalities in job opportunities, wages and education" (Government Office for Science, 2011). Currently many more jobs and other financially beneficial opportunities are located in cities, which are more frequently located on the coast. These cities are attractive to low-income, low-opportunity inland areas, causing a net migration towards the coast. However, once SLR begins to have severe impacts on these cities, it is likely that the opposite will occur and these at-risk areas will experience net migration inland, away from the dangerously rising waters.

2.3 The Antarctic Research Center

2.3.1 The Antarctic Research Centre and Their Research

The Antarctic Research Centre (ARC) is a global research organization headquartered in Wellington, New Zealand. The ARC was founded in 1972 by Peter Barrett as part of the Geology Department of the Victoria University of Wellington. As an organization that is committed to furthering the Antarctic scientific community, the ARC focuses on studying historical geological data in order to make predictions about future glacial movements. Specifically, their research concentrates on the response of the Antarctic cryosphere to past global climate systems. Using historical response data they collect, the ARC makes predictive models to show how the Antarctic might respond to a changing climate in the future. More recently, the ARC has become more focused on studying the contributions of changing Antarctic ice sheets to global sea level rise based on the Intergovernmental Panel on Climate Change's (IPCC) carbon emission projections. The IPCC has modeled 4 different represen-

tative concentration pathways (RCPs): RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5 (Moss et al, 2008). These model different potential changes in sea level rise based on greenhouse gases, with RCP 2.6 showing a minimal change in sea level rise and RCP 8.5 showing a very pessimistic model with large increase in sea level rise. The ARC, as well as other research organizations, have become very interested in studying the projections for each of these IPCC models.

Members of the ARC have been conducting annual expeditions to Antarctica since 1957 to collect samples of ice and rocks. Additionally, the ARC is one of the leading research groups in Antarctic ice coring. Ice coring is the process of drilling through glacial ice sheets to retrieve a cylinder of ice, up to several meters in length, that represents thousands of years of atmospheric data trapped in the ice crystal lattice. Additionally, rock samples dropped from retreating glaciers are collected as a method to analyze the history of glacial movements in Antarctica. These samples are used to study the mechanisms of modern glaciers evolution, glacial marine environments, and atmospheric systems. Their main approach consists of reconstructing the effects of past periods of high temperatures and CO2 on the oceans, ice sheets and ice shelves. In order to do so, the ARC implements numerical modelling which allows for more robust future projections. Their ice sheet model simulations and geological data suggest that a large part of the West Antarctic ice sheet may eventually retreat, as long as the atmospheric CO2 concentration remains at 400 ppm or higher.

2.3.2 Science Communication Initiatives

Although the ARC was originally founded as a research organization, it has since become aware of the importance of educating the public about climate research. Therefore, fifteen years ago, the ARC decided to add another pillar to the organization's mission statement, to "Promote the study of the Antarctic and its value to society" (About Us-Antarctic Research Centre, n.d.). In that time, the ARC has adopted a range of small-scale outreach strategies to disseminate its research to the public. For example, many members of the ARC are professors

and participate in teaching undergraduate and graduate courses at the Victoria University of Wellington. Many of the ARC's members also give informal presentations to clubs and school groups with whom they are affiliated. Additionally, the ARC has maintained a media presence through making appearances in various documentaries such as "Thin Ice", as well as by holding interviews on the radio and various news channels. One of their main outreach tasks is advising various local public officials on topics in climate change.

As part of their work with other science research organizations, the ARC has recently joined a sea level rise initiative called the NZ SeaRise Programme. This program combines research from many institutions, including the Victoria University of Wellington, the Institute of Geological and Nuclear Sciences (better known as GNS Science), the National Institute of Water and Atmospheric Research (NIWA), and a number of international universities such as Rutgers, Leeds, and the University of Massachusetts at Amherst . This program aims to combine the resources of all of these global institutions in order to create improved models for sea level rise and its impacts on New Zealand.

Despite incorporating the public science communication into the ARC's mission statement fifteen years ago, the organization's public outreach is still in its infancy. Many of the ARC's outreach programs only target a couple dozen individuals at a time. One example of this is the climate lecture series. Moreover, these programs are primarily technical and are targeting academic and scientific communities, making the content harder to understand for the average listener. The ARC is aware of this gap and they are now seeking to improve their public science communication strategy.

2.4 Science Communication

2.4.1 Defining Science Communication

Science communication is the practice of effectively communicating an area of science from the scientific community to the general public. For this project, the focus is on commu-

nicating climate science, specifically sea level rise. In order to make decisions about climate issues, it is necessary to have a grasp of the relevant science and research. By arming people with the facts, they will be more prepared to make educated decisions for their future. This includes not only personal decisions, such as buying a fuel-efficient vehicle or an electric car, but also public policy decisions, such as whether or not to tax agricultural carbon imprints. For that reason, effective science communication is necessary to inform people about the benefits, risks, and other aspects of their decisions, thereby allowing them to make sound choices. By providing the public with a common and solid understanding of the scientific facts, people will not be concerned with the validity of the science, but rather with making decisions based on this science. Effective science communication strategies employ four interrelated tasks (Fischhoff, 2013):

Task 1: Identify the science most relevant to the decisions that people face. The first step is to separate the most relevant scientific facts that the public needs to know to make an informed decision, from the myriad of scientific information that exists on a certain topic. This process will depend on which decisions the science communication is seeking to inform. Moreover, since decisions are defined by the goals and circumstances of those who make them, different scientific facts might be relevant to different decision makers.

Task 2: Determine what people know. In order to determine how much an individual knows, it is important to make use of open-ended questions and interviews, in order to allow the individual to express their ideas and beliefs fully. Other methods, such as focus groups, provide the opportunity to hear from many people at once; however, they also make it harder to extract an individual's views in depth. With a better understanding of the public's beliefs, a more structured survey can be created that pose precise questions to assess respondents' knowledge of the science.

Task 3: Design communications to fill the critical gaps between what people know and need to know. Ultimately, science communication is meant to provide answers to people and create mental models of abstract science that can be better understood by the

public. Behavioral research has revealed a series of principles about people's behavior that can be used in science communication design. For instance, one of the principles says that people consider the return on their investments in making decisions, while another states that people have difficulty projecting nonlinear trends.

Task 4: Evaluate the adequacy of those communications. Whether communication is effective or not depends on its content, its accessibility, and the form in which it is presented. Communication is effective if it contains the information that recipients need, if it can be easily accessed by people, and if it is presented in a way that people can comprehend and extract meaning. Although many of this criteria will not necessarily be true for all of people, communication is still considered to be adequate if these criteria apply for most people.

2.4.2 The Science Communication Paradox

Communicating scientific facts effectively to the public presents a challenge. At the core of this challenge sits the paradox that "human societies have never known so much about mitigating the dangers they face but agreed so little about what they collectively know" (Kahan, 2015). Multiple studies have investigated this phenomenon, trying to understand and devise a meaningful explanation. Among the numerous hypotheses that attempt to interpret this paradox, including science denialism, public irrationality and misinformation, the cultural cognition thesis (CCT) stands out. The CCT argues that certain types of group affinities will shape the individual's perception of facts, including compelling scientific data. The idea that people will adapt their assessment of evidence to conform to a goal unrelated to accuracy but merely based on emotion or motivation (Kahan, 2015), also known as "motivated reasoning" is central to this hypothesis. Therefore, separating between cultural meaning and scientific fact is of vital importance when communicating the effects of SLR to the public (Kahan, 2012).

2.5 Psychological Frameworks to Understand Perceived Risk

The goal of science communication is to create an informed populace. However, once the public is aware of a dangerous situation, the public immediately interprets the information provided and perceives the risk associated. Science communicators try to align the public's perceived risk of a situation with the experts understanding of the actual risk, however, there is usually disconnect between the information given and the risk perceived. Therefore, psychologists have been trying to understand how individuals perceive risk in order to better align the actual risk with the public's perceptions. By understanding how the public can misassess the risk, communicators can change techniques to offset the perceived risk. This section will discuss two psychological frameworks, cognitive heuristics and social amplification. Each framework is used to understand one facet of how the public responds to information and risk perception.

2.5.1 Cognitive Heuristics

Cognitive heuristics, also known as psychometrics, are evolutionary psychological shortcuts human brains developed as part of its evolution to judge the risk involved in life-threatening situations with minimal information and time (Perrella & Kiss, 2015). For example, when someone experiences a loud noise, most people jump and their heart starts racing. This is not a conscious decision made by the brain, but is instead an instinct that prepares an individual to react even if the cause for the loud noise does not pose a threat. As a result, human brains use these shortcuts to judge risk even when all of the information is presented, leading to perceived risk that does not align with the situation (Mander et al., 2011). The cognitive heuristic theoretical framework only explains why people perceive information in a certain way; it does not predict how specific individuals will react (Kahneman

et al., 2006). Therefore, the benefit of cognitive heuristics is to provide a guide for potential reactions to consider when disseminating information. A knowledge of common biases and how they impact perceived risk, shown below in Table 2.1, can therefore allow researchers to develop strategies to best present information to convince the public of the risks of SLR (Krimsky & Golding, 1992).

One common heuristic is the credibility heuristic. The credibility heuristic explains how individuals react to information presented from a perceived trustworthy or untrustworthy source, as well as what principles can make a source untrustworthy (Perrella & Kiss, 2015). These principles include: pre-existing mistrust, the presence of controversy, and perceived uncertainty. Gifford (2011) posits that trust between the public and the sources of information is essential for informing the public and changing behavior. There are numerous methods that an information source can lose the trust of the public such as through exaggerating statistics, falsifying data, or misusing resources. Once the public mistrusts an institution, any information presented is thrown into question and discounted because the institution's motivations are doubted (Gifford, 2011). From the public's perspective, the institution may not have the public's best interest in mind. Perrella & Kiss (2015) also note that when experts are at odds with each other, they risk polarizing subsets of people which causes them to perceive significantly more or less risk compared to the public at large. This ties in with how the public perceives uncertainty. When scientists communicate uncertainty and the likelihood of an event occurring, the public underestimates the risk associated with the predicted event (Gifford & Hine, 1996). This is due to a misunderstanding between the definitions of uncertainty. The public views uncertainty as a reason to ignore the risk because if the experts are not certain about the impact, then why should the average person be worried. However, scientists define uncertainty as accounting for probabilistic deviations in their findings. This places a significant amount of power into the hands of the media and experts because they are the main sources of public information (Kahneman et al., 2006). These sources tend to report on stories that are not reflective of the complete profile of long

Cognitive Heuristic	Key Principles	Summary of Impact on Risk
Credibility Heuristic	Trust vs Mistrust, Controversy, Uncertainty	The trustworthiness of a source impacts how the public estimates the risk associated. The more credible a source the more likely the individual will accept the information
Availability Heuristic	Availability, Confirmation Bias, Representativeness heuristic	The recency, and quantity of examples of an event increases the risk associated with it. However, individuals are prone to thinking that bad things will never happen to them
Affect Heuristic	Emotional Response, Diffusion of Responsibility, Environmental Numbness	The greater the emotional response to an issue, the higher the associated risk perceived. However, the longer the time scale and the more discussed an issue is, the lower the perceived risk

Table 2.1: Cognitive Heuristics

term risk, and therefore the public's perceived risk for some events are higher than other, more logical risks (Kahneman et al., 2006).

Another heuristic is the availability heuristic, which suggests that individuals are more likely to perceive risk when recent, relevant examples come to mind (McDowell et al., 2013). Humans tend to focus on more imminent and urgent risks, because the brain does not comprehend long-term threats or risks well, especially if they do not feel personal (NOAA, 2016). This heuristic is based off of a set of biases that shape how people interpret information relating to them. One such bias is the confirmation bias, the concept that humans reaffirm their own preconceived notions on a subject by ignoring information that contradicts the original assumption (Maldanato & Dell'Orco, 2011). The confirmation bias is not necessarily willful ignorance, but can manifest as the lack of the individual accounting for a falsifying case (Maldanato & Dell'Orco, 2011).The confirmation bias is useful to understand in the context of risk perception because of a common held belief that "[the risk event] will not

happen to me" (Kahneman, 2006). The human mind has trouble imagining events it has not already experienced and therefore extrapolates possible outcomes, called the representativeness heuristic (McDowell et al., 2013). A common example of this is the inability of humans to conceptualize floods that have not occurred in recent memory which leads to the belief that if an event has not occurred in the past, then there is no risk it will impact them in the future (Kahneman, 2006). Therefore, if there are few or no examples of SLR that exist in the New Zealand consciousness then the perceived risk will be low or non-existent.

The final heuristic relevant to SLR is the affect heuristic. Affect is defined as the immediate emotional response evoked from an idea or event (Affect, n.d.) The affect heuristic describes the role that emotions, intuition, and instinct have on the perception of risk in serious, unknown, or unfamiliar situations (Stevenson et al., 2015). Stevenson et al. (2015) argue that in a discussion relating to climate change, people tend to ignore statistical facts and instead use the emotional response of the information presented to make decisions (Maldanato & Dell'Orco, 2011). Maldanato and Dell'Orco posit that emotions are the best way to understand perceived risk due to direct link between cause and effect. One psychological event that may lower the emotional response that SLR has on risk perception is the diffusion of responsibility. Diffusion of responsibility is the concept that a person will feel less pressure and be less likely to take action in a large group because they assume that another person is responsible to handle the situation (Diffusion of Responsibility, n.d.). This applies to SLR perception because on a decades long time scale, individuals feel less pressure to act because they believe it unlikely that they will experience the negative impacts of SLR in their own lifetime and that someone in a position of authority will fix the problem. This results in a disconnect between the understood impacts of SLR and the perceived impact upon each individual. This therefore reduces the overall risk perception held by the public as a whole. Another subtheory of the affect heuristic is that people can become desensitized to an issue, known as environmental numbness (Gifford, 1996). This desensitization occurs because the risky event is minimized compared to other more pressing events, discussed earlier in the

availability heuristic. Additionally, the risk event could have been advertised too much and the public's attention to the event decreases as result of the risk event being incorporated into their new idea of normal (Gifford & Hine, 1996). By synthesizing these subtheories into the affect heuristic, a better understanding of how influencing the public's emotions can impact their perceived risk of a situation.

2.5.2 Social Amplification

Social amplification is a term originally created by Kasperson et al. (1988) to explain that the risk understood by the public is a result of a feedback cycle between the public and the government. However, this definition has expanded to include several separate theories including social norms and social comparison. The original theory of social amplification of risk pertains to the feedback relationship between the public and local government officials. The public has an initial perception of the risk associated with some event which results in political and economic policies to respond to the risk. These policies then have their own associated risk perceptions, which the public then reacts to and new policies are put into place (Kasperson et al., 1988). In 2011, Chung used social amplification to encompass public-public interactions as a result of the prevalence of the internet. Chung suggests that the social amplification of risk is significantly higher due to the ease with which people are able to disseminate and absorb information, especially in sensationalized online media stories. Chung (2011) notes that a small number of individuals can have a much larger impact on discourse online, even though a large number of comments and articles are positive, a small, vocal group of people can create controversy over a topic. This is caused by phenomena known as social norms and comparison. Social norms and comparisons explains that people take cues from individuals and groups around them to dictate what the proper course of action is (Gifford 1996). This can encompass the degree at which people view risk, where if the people around an individual think SLR is a pressing issue, then that individual is more likely to agree with them. This phenomenon is particularly prevalent on the internet because

it is much easier to surround oneself with likeminded people to reaffirm their beliefs (Chung, 2011). Therefore, these people tend to have much stronger convictions about the perceived risk of a situation irrespective of the information provided. This creates a hurdle that must be overcome in any public communication from climate experts.

Chapter 3

Methodology

The goal of our project was to develop recommendations to improve public science communication methods to connect our sponsor, the Antarctic Research Centre (ARC), to the public. The team accomplished this goal by completing the following three objectives:

1. Objective 1: Gauge the public's understanding and perceptions of sea level rise in Wellington's Central Business District.

2. Identify effective methods of communicating climate research that local public officials and science communication experts have utilized.

3. Design communication strategies to effectively communicate sea level rise to the public based on findings from Objectives 1 and 2.

Our work on these objectives yielded three deliverables for the ARC. The first deliverable was an analysis of the public's knowledge and perceptions of sea level rise. The second deliverable was a synthesized list of best practices in public science communication from experts in the field. Finally, the third deliverable was a series of suggested public communication strategies for the ARC based on what we learned about the public in Objective 1 combined with the best practices from Objective 2. A full description of the flow of the project is depicted below in Figure 3.1.

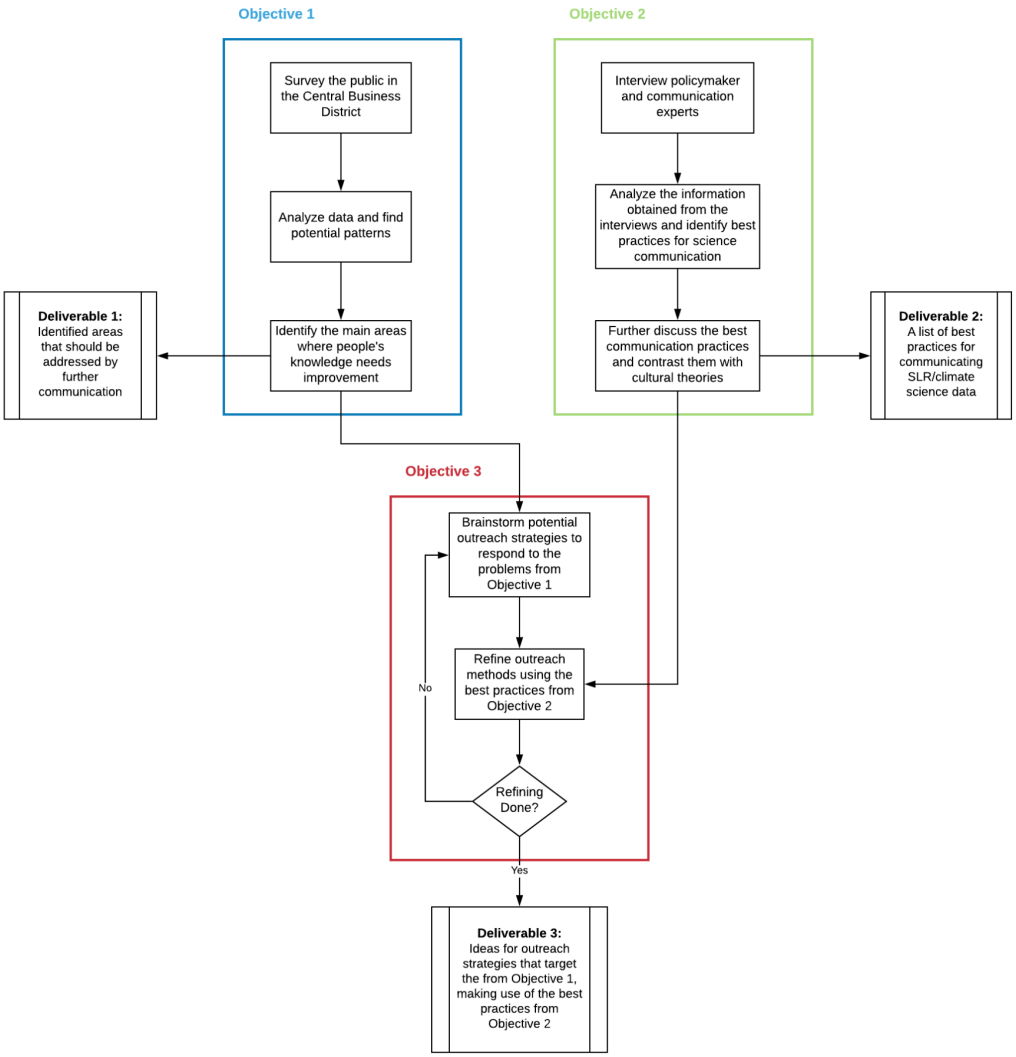

Figure 3.1: Project Flow Diagram

3.1 Stakeholders in the Central Business District of Wellington, New Zealand

For the purpose of this project, the team identified four main stakeholder groups: climate researchers, science communication experts, local public officials, and the Wellington public.

3.1.1 Climate Researchers

The first stakeholder group that the team identified was climate researchers. These are groups such as the ARC that perform climate research with the purpose of expanding the scientific community's understanding of climate change by creating models and projections for future events. The information that this stakeholder group usually produces is high-level and technical, as their typical target audience is others researchers in the scientific community. As a result, their publications tend to be difficult to read for the general public. Therefore, this is the stakeholder group that our communication recommendations are targeted for.

3.1.2 Science Communication Experts

The second stakeholder group that the team identified was science communication experts. Their main stake is turning technical information produced by climate researchers into information that is more easily consumable by and available to the general public. Our team will utilize knowledge from this stakeholder group to guide the initial phases of the prototyping process for our proposed public communication strategies, especially in terms of strengths and weaknesses of their previous experiences in public science communication. Groups that we sought out to interview to represent this stakeholder group included experts from the Te Papa Museum, NIWA, and current science communication professors at the Victoria University of Wellington and Rutgers University.

3.1.3 Local Public Officials

Local public officials were the third stakeholder group identified by the team. This group intends to encompass local public officials for the Wellington region specifically. Their job is to create policies in the best interest of the public such as initiatives to respond to community threats, namely sea level rise. Similar to science communication experts, public officials have experience in effectively communicating information to the public. For public officials, they

have experience with communicating a problem in the community, its impacts, and their proposed policy to manage it. Our project benefited from learning from their knowledge and effective practices. Groups that we sought out to interview to represent this stakeholder group included members of the Greater Wellington Regional Council (GWRC) as well as members of the Department of Conservation (DoC).

3.1.4 Wellington Public

The final stakeholder group is the Wellington public. This includes visitors, residents, and workers of Wellington City, specifically in and around the Central Business District. The purpose for including this group is that they are at risk from sea level rise. This includes property damage, higher costs of living from impacts discussed earlier in this chapter, and even risks to their personal safety. However, this stakeholder group has little control over how they will be impacted by SLR and implementing methods to mitigate this impact. Therefore, the Wellington public is the target audience for the science communication strategies that we will recommend to the first stakeholder group, the climate researchers. By improving the communication between climate researchers and the public, the public can be more informed and more effectively advocate for themselves regarding sea level rise.

3.2 Objective 1: Gauge the public's understanding and perceptions of sea level rise in Wellington's Central Business District

The first step in our project was to survey the public to understand how they perceive sea level rise as well as how much they know about it. In this step, we sought to learn what the public understands about sea level rise and how they interpret the information they have. This assessment allowed us to identify the types of information that the ARC should focus

on communicating to the public in the future.

3.2.1 Survey Design

To design our survey, we first identified the types of information that the would be useful for the ARC. We used background SLR research, discussed in sections 2.1 and 2.2, to select important concepts that the public should be aware of and then used those concepts to brainstorm survey questions. Some of the concepts we identified included general SLR knowledge, the spatial and temporal impacts of SLR, and the comparative impacts of SLR. These are shown in Table 3.1 below.

The team then brainstormed and listed questions about SLR that could be categorized into these five categories. The list of questions was then narrowed down to only a handful that targeted the information most effectively. Next, we refined the wording of each question to make it as clear and as unbiased as possible. For example, one of the questions that the team brainstormed was, 'What do you believe are the causes of sea level rise, if any?' In this case, we decided to ask this question as open response because this would allow each respondent to answer in their own words without a bias from the surveyors. We selected multiple choice, free response, scaled, and visual aid questions to be employed in our paper-based survey. We then discussed the sequence in which to present the questions, and eventually arrived at a reasonable order for our 18 questions. This preliminary survey was then reviewed by members of the ARC to ensure the questions were worded in a manner familiar to Wellington residents. The first iteration of the full survey is shown in Appendix A.

The team decided to administer this survey as a convenience survey because this method allows researchers to gather a large body of information. Surveys facilitate uniformity in response, thereby simplifying analysis and pattern identification among responses. Due to the fact that this project is concerned with the geographic area of the Central Business District, convenience sampling was determined be the most useful method to gather information related to the Wellington public. Convenience sampling is a method of targeting a group of

Topic About SLR	Purpose
SLR Knowledge	To determine the extent of the public's knowledge about SLR.
Spatial Impact	To understand what areas of Wellington the public believed would be affected in a specified time frame.
Temporal Impact	To understand what time frame the public believed they, and the city of Wellington, would be significantly impacted by SLR in.
Comparison to Natural Disasters	To Understand how respondents perceived SLR in contrast with other natural disasters that occur regularly in New Zealand, such as earthquakes, tsunamis, and storm surges.
Demographics	To perform more in depth analysis of the respondents to determine the presence of trends across demographic groups.

Table 3.1: Survey Question Topics and Purpose

participants that are more readily available to researchers due to location, timing, or some other criterion that makes sampling easier (Bernard, 2015). This sampling method is used when the reason for convenience aligns with the purpose of sampling or when randomness and diversity in the sampling is not important relative to types of information gathered (Bernard, 2015). One such sample is when the general information or baseline knowledge needs to be gathered for varied groups of people (Bernard, 2015), which is the case for our project.

3.2.2 Survey Pilot

Once the team arrived in Wellington, we were able to test the survey in a small pilot. The team broke into two groups of two people each in order to administer the survey in the Central Business District of Wellington. Within each group, one member acted as the lead surveyor and administered the survey questions orally, while the other member recorded the

respondent's answers to each question on a clipboard. We received recommendations from the ARC regarding areas that would likely be best for surveying due to high foot traffic. The groups then separated to pilot the survey is several of these suggested areas.

Within our pilot, we administered the survey to 44 participants over the span of two days. We received feedback from each of our respondents regarding questions that were unclear as well as ways to improve our wording within several of the questions. This feedback, as well as the preliminary results from these surveys, led us to delete one question that was not well received, and add a new question that was worded more effectively. The refined convenience survey is found in Appendix B. The pilot survey also offered us many other opportunities to improve not only our survey, but also our surveying technique. Through this pilot period, we learned that we had the best success when surveying between the hours of 11am and 2pm. Additionally, we found several locations where our surveying was most effective. These are shown below in Figure 3.2 below. This piloting period allowed us to improve our overall surveying experience so that we could have more success while administering our convenience survey.

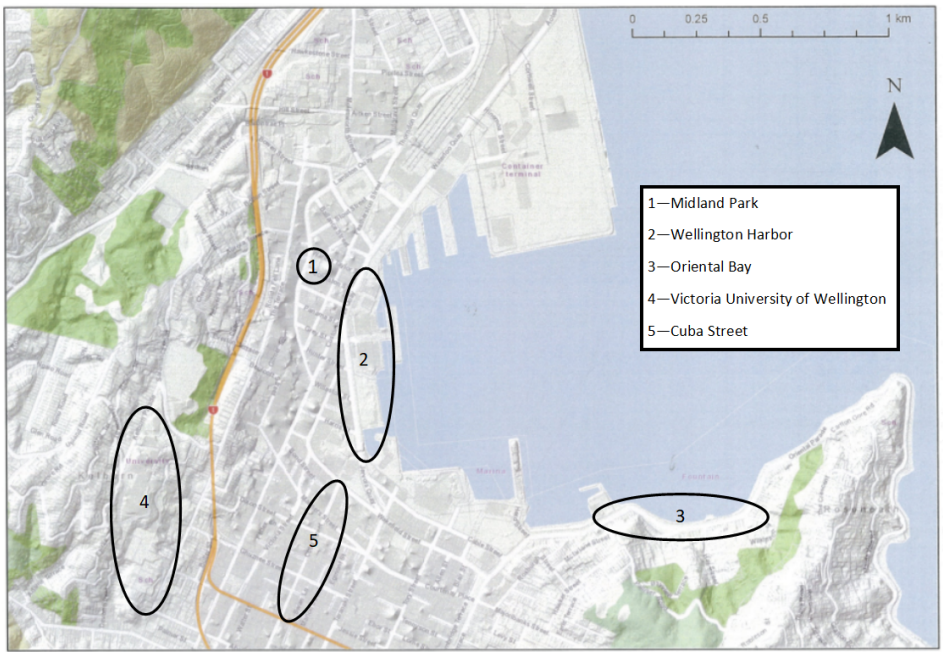

Figure 3.2: Map of Surveying Locations

3.2.3 Data Collection and Data Management

When we administered a survey, the interviewer would read the team's process of consent statement to ensure that the data collected was gathered voluntarily and ethically. The process for consent was delivered as follows:

Hello, would you be willing to participate in a 5 minute survey about sea level rise? We are a group of students from an American university called Worcester Polytechnic Institute. We are conducting a research project which will be published through our university. Our goal is to research the public understanding of sea level rise, in order to improve public communication of new environmental information. Therefore, we would like to know what you know about sea level rise in Wellington. Your participation is voluntary meaning you do not have to participate and you can skip any question you feel uncomfortable answering. We will only be using personal information to understand the demographic distribution, we will not be publishing any identifiable information. Do you have any questions about this survey?

After the survey was administered, the group's contact information was provided to the interviewee in case they wanted to follow up about the interview or ask any further questions about the project after the survey.

Surveys were administered in the same method as the pilot, in groups of two team members, with one administering the survey orally while the member took notes and recorded responses. The note taker also recorded visual observations about the respondent, such as demeanor and quotable responses. Additionally, we administered surveys to individuals as well as groups of two to four. This allowed us to more efficiently survey a larger number of individuals, however, we ensured that each individual answered each question on their own and got verbal confirmation if they agreed with another respondent's answer.

While administering the convenience survey, responses were collected on a paper survey

and map. Each survey and map was numbered to keep respondents' information together. Survey responses were recorded into a Microsoft Excel spreadsheet to allow for ease of data analysis and comparisons between responses. The map portions of the survey were scanned into a PDF format to be analyzed as discussed in the next section.

3.2.4 Data Analysis

The data analysis for this section was broken up into 5 categories: SLR knowledge, temporal impacts, spatial impacts, comparative risks of SLR, and demographics. These information categories are discussed in Table 2 in section 3.1.1. This allowed us to compare findings between different categories such as cross referencing demographics with comparative risk of SLR.

Sea level rise knowledge is one main category that we wanted to understand how much the public knows. One open-response question in our survey that targeted this category asked respondents to identify what they believed were the main causes of SLR. We coded responses for this question using the frequency with which respondents mentioned different causes of SLR, such as global warming, climate change, and melting ice. Additionally, another survey question asked respondents to estimate how much the sea level would change in Wellington in 50 years. We also coded these responses into several categories such as no change, 0-0.5m, 0.5-1m, 1-2m, and ¿2m and then counted for frequency of responses.

Similarly, two of our survey questions focused on temporal impacts. One of these questions asked whether the individual thought that they would be impacted in their lifetime by SLR. This question was presented as binary a yes or no question, and we analyzed these results quantitatively. Another survey question asked when the individual believed the government should implement a policy to respond to SLR in Wellington. The responses were categorized into groups such as ASAP, within 5-10 years, within 10-20 years, and ¿20 years. These responses were then analyzed for frequency of occurrence.

In order to evaluate public understanding of spatial impacts, we implemented a visually-

based question in our survey. In this question, we presented respondents with a map of the downtown Wellington area and asked them to shade in the areas that they thought would be impacted by SLR within 50 years. The map responses were then scanned into PDF format. The team used Adobe Illustrator to overlay a grid with squares scaled to 1/16th of a km onto the map. Then, each square that was at least 50 percent shaded was given a score of +1. The score for each square was summed over all map responses, and this value was used to create the heat map. This means that squares with a higher score represented areas that more people thought to be at risk from SLR. The heat map was then uploaded to ArcGIS and converted into a data layer. This allowed the heatmap to connect with geographic data points, which provided a more meaningful output to the ARC.

To understand public perception of comparative impacts, the team included questions that asked respondents to compare SLR and natural disasters. These questions asked individuals to tell how at risk they felt on a scale of 1-5 to three different natural disasters, as well as sea level rise. Similarly, another question asked individuals to use the same scale to tell how prepared they were to respond to the same three different natural disasters, as well as sea level rise. The responses were analyzed using statistical analysis to find the median and mode for each risk event. The team performed quartile analysis on this question so that we could show the distribution of responses in a meaningful and visual manner.

Finally, demographic data was preliminarily used to compare the survey respondents to the demographic distribution in Wellington to determine how accurately our data represents the Wellington populace. Additionally, the demographic data was used to further investigate the other information topics by dividing respondents into subgroups to determine more specific trends. This method is known as cross-tabulation. Cross-tabulation is traditionally an analysis method that is used to determine the scale between two variables (Jays, 2011). Our team cross-tabulated between each demographic group and each question about SLR and graphed the result to determine if there was any pattern between the two questions. If there was a noticeable pattern, we then determined if that result was significant in terms of

science communication. If there was no pattern or relevance to science communication, then that table or graph was not further analyzed.

The results from this analysis of the public's understanding of SLR comprised the team's first deliverable to the ARC. Using the data collected and its analysis, we obtained several patterns, which we discuss in the results section. These results were then synthesized and used to identify findings, which guided our brainstorming in suggesting communication strategies to the ARC.

3.3 Objective 2: Identify effective methods of communicating climate research that local public officials and science communication experts have utilized

The next step in our project was to learn how local public officials and communication experts communicate climate science to the public. Our main purpose for this objective was to understand how the past experiences of public officials and experts in science communication had been successful and what methods had been detrimental to their effort. This discussion allowed us to generate a list of best practices from their experiences. We were then able to utilize their suggested best practices to build a stronger set of outreach recommendations for the ARC.

3.3.1 Establishing Connections with Groups of Interest

Upon arrival in Wellington, the team performed extensive research on local science communication experts. To do this, we first identified organizations and people who had experience relevant to communicating climate science and specifically sea level rise with suggestions from Dr. Tim Naish. For public officials, we identified the Greater Wellington Regional Council as well as the Department of Conservation as organizations of interest. Similarly,

the team identified Te Papa Museum, and several science communication professors at the University of Victoria as experts in the science communication field that we were interested in learning from. Once these groups and people of interest were identified, the team used connections through the ARC to establish contact with individuals. We then contacted them through email in order to schedule meetings at mutually convenient times in and around the Wellington region.

3.3.2 Interview Design & Administration

The interviews we conducted were in a semi-structured format wherein interviewers prepare a set of questions topics to discuss, but the interviewers are also permitted to ask more probing questions (Bernard, 2015). This allowed the team to set a more conversational tone, and it also allowed the interviewee to share their experiences in the field. This permitted the team to follow up on certain topics and follow lines of questioning that would not be possible during a structured interview.

Prior to each interview, the team researched the interviewee and their experiences in science communication in order to be as knowledgeable as possible. This allowed the team to ask questions that were better at connecting to the interviewee's experiences and therefore providing more information to our team. Additionally, when possible, we referenced specific outreach campaigns that the interviewee had participated in or publications that they had contributed to in order to build rapport with the interviewee. Although each of the interviews were slightly different due to their semi-structured nature, the team developed a list of basic questions that we wanted to ask each interviewee. These questions are shown in Appendix C.

Two team members participated in each interview. One member acted as the lead interviewer and asked questions from the basic interview form shown in Appendix C, while the other member took notes and asked follow-up questions when necessary. With the consent of each interviewee, the team recorded the interview for later transcription by using the Voice

Recorder App on Android and iPhone.

3.3.3 Interview Analysis

To analyze the interviews, the team first transcribed each interview from voice recording to a text document using Trint, a transcribing software. A team member then checked the transcription with the audio recording to correct any mistranscription by the software. Then, the team was able to code each interview for patterns and common topics that were prevalent between each of the interviews. Coding is a way to convert the qualitative data collected into quantitative values by identifying key, recurring phrases and counting responses that fall under distinct themes (Bernard, 2015). The coded responses were then used to develop a set of communication best practices by noting when each expert made a recommendation and then cross checking the notes from each interview in order to see when the same recommendations were made by multiple experts. These best practices were synthesized and given to the ARC as our second deliverable. This can be found in Appendix K.

3.4 Objective 3: Develop communication methods in response to findings observed in objectives 1 and 2.

The final step in our project was to utilize what we had learned from objectives 1 and 2 in order to recommend better ways for the ARC to communicate their science research with the public. This step involved using an iterative design process to rapidly prototype potential communication strategies (Martin & Hanington, 2012), then evaluating their likelihood of success using a SWOT analysis. In this way, the team was able to create several recommendations to give to the ARC to improve their outreach with the Wellington community.

To complete this objective, the team first spent time individually ideating potential

communication strategies. After individually creating a list of potential strategies, we then met as a group for another brainstorming session. In this session, each team member wrote down their ideas from their individual ideation onto sticky notes and stuck them to the wall. After all ideas were presented, the entire team was able to organize every idea that had been produced into groups of similar topics. Some such topics included "Art Installations", "Social Media", and "Online Simulations". After all ideas were presented and grouped, the team performed a quick feasibility check on each of the ideas. This was an extremely low-level reality check to determine if any of the ideas were out of the realm of possibility. Only ideas that were not possible for the ARC to undertake by any means were removed. By performing this initial check, the team was able to ensure that only feasible ideas made it to the next step of the design process.

After many ideas had been produced and sorted into groups by topic, the team then shifted into focusing on refining and expanding on these ideas rather than continuing to propose new ones. We then brainstormed details for each of the proposed topics to elaborate how each idea could be implemented and what each idea should include in order to be successful.

Once several rounds of the iteration had been completed, we performed a SWOT analysis on each of the groups of communication strategies. SWOT stands for strengths, weaknesses, opportunities, and threats (Caprarescu, Stancu, & Aron, 2013). This method of analysis makes an in-depth assessment of each of the strategies based on each of these four categories (Caprarescu, Stancu, & Aron, 2013). The SWOT analysis was analyzed based on the public's needs we identified in Objective 1, and the best practices identified in Objective 2. We implemented this analysis by making note of strengths when a proposed strategy implemented a best practice as described in Objective 2 or addressed a finding from Objective 1, and weaknesses when a strategy failed to do either of those. Opportunities or threats were identified in terms of ways the strategy could positively or negatively impact the ARC. Strategies that addressed at least two out of our three Findings from Objective 1 made up

our final recommendations to the ARC. The development of the final ideas and their SWOT analysis will make up our recommendation, which is our third deliverable to the ARC.

Chapter 4

Results and Discussion

Through working to understand current public perceptions of sea level rise, as well as the best practices of science communication in Wellington, we were able to identify several potential methods to improve sea level rise communication with the public. This chapter focuses on the findings we obtained throughout our data collection and analysis as well as the methods to assess our proposed solutions.

4.1 Objective 1: Gauge the public's understanding and perceptions of sea level rise in the Central Business District

To address our first objective, we administered convenience surveys to the public in order to understand what they know about sea level rise and how they perceive the phenomenon. The findings from the 153 surveys that we collected are presented in this section.

To analyze our survey data, we used a combination of methods to look at both our qualitative and quantitative data. Through coding, statistical analysis and cross-tabulation we were able to identify initial patterns in our data. By comparing responses to each demographic group as well as to each other, we were able generated graphs analyze them to

determine if any significant patterns appeared. This section discusses the significant patterns that were found from the surveys and how these patterns are relevant to communicating SLR research to the public.

4.1.1 Results & Analysis

Result 1: The Wellington Public's Level of Awareness of SLR

The first significant pattern that we identified from our convenience surveys was that our respondents believe that they are reasonably informed about sea level rise. One of the questions in our survey asked respondents to rate their awareness of sea level rise on a scale of 1-5, with 1 representing very little knowledge about the subject and 5 representing a high level of knowledge. Based on answers from 110 respondents, the median and mode of self-reported knowledge was 3. A median and mode of 3 indicated that our surveyed population believed that they are relatively aware of the subject because it is the midpoint between the given scale. Additionally, only 9 respondents, or 8%, self-reported as not knowing about SLR. The response distributions from this question are shown below in Figure 4.1.

This finding that the public believes that they have some basic level of knowledge on sea level rise was corroborated by other data gathered from our survey. Another question asked respondents to list the causes that they believed contributed to sea level rise. This question was asked as an open-ended response, and participants were allowed to give as many responses as they wanted. After gathering our results (n = 153), we compared the causes identified in the responses with our background research and the ARC to determine which responses were correct. Some of these such correct responses included global warming, climate change, thermal expansion, and global ice melt. About 90% (n = 137) of respondents were able to identify at least one correct cause of sea level rise. Additionally, 35% (n = 53) of respondents were able to correctly identify two or more causes of SLR, however, only 10% (n = 15) were able to identify three or more causes. Although this result is not able to fully

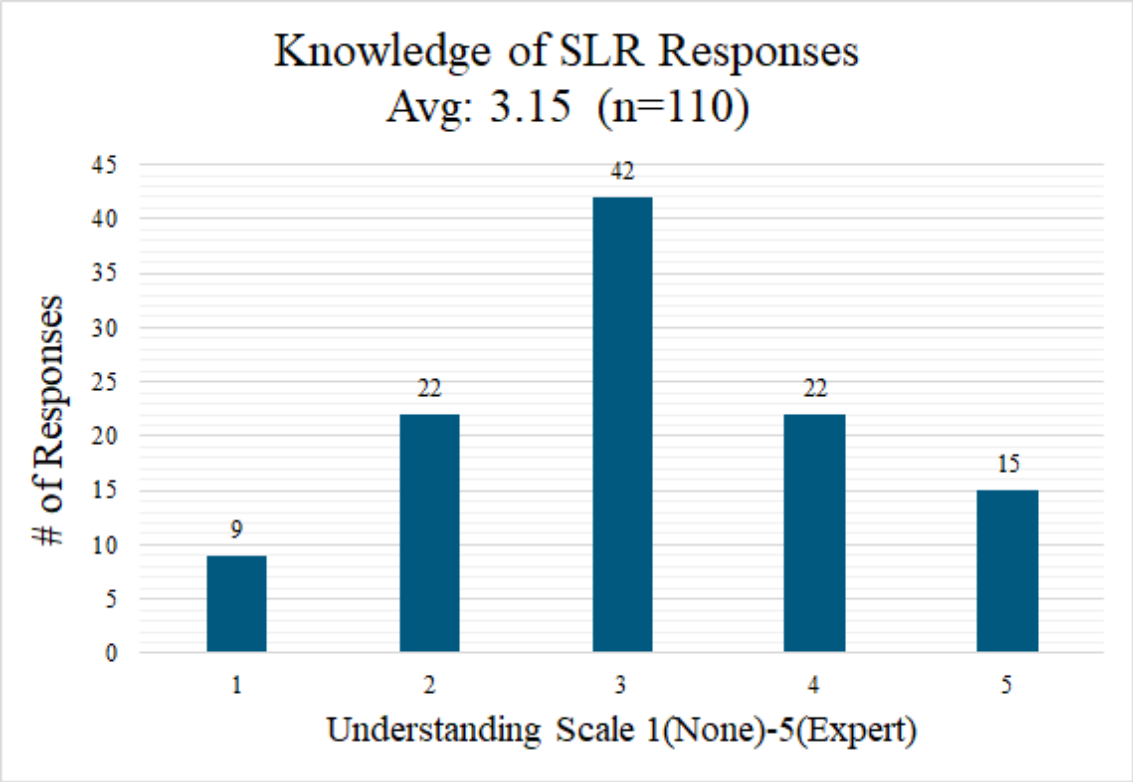

Figure 4.1: Self-Reported SLR Knowledge

show respondents' depth of knowledge, this question does corroborate the claim that our surveyed population does have some awareness of sea level rise.

This result was further corroborated by another question on our survey, which tested respondents' knowledge of the spatial impacts of sea level rise. In this question, we presented participants with a printed map of Wellington harbor, and asked them to shade in the areas of the map that they believed would be most impacted by sea level rise in 50 years. After collecting all these responses, we synthesized them into a heatmap, and used LIDAR data to overlay elevation lines on to the map to represent 1, 2, and 3 meters above sea level as discussed in methodology section 3.1.4. This heatmap with elevation lines is presented below in Figure 4.2.

We worked with the ARC and used our background research to determine whether the darker regions of the heat map followed projections, or were misinformed. The consensus was that if the majority of respondents were able to stay within the 2-meter line and the

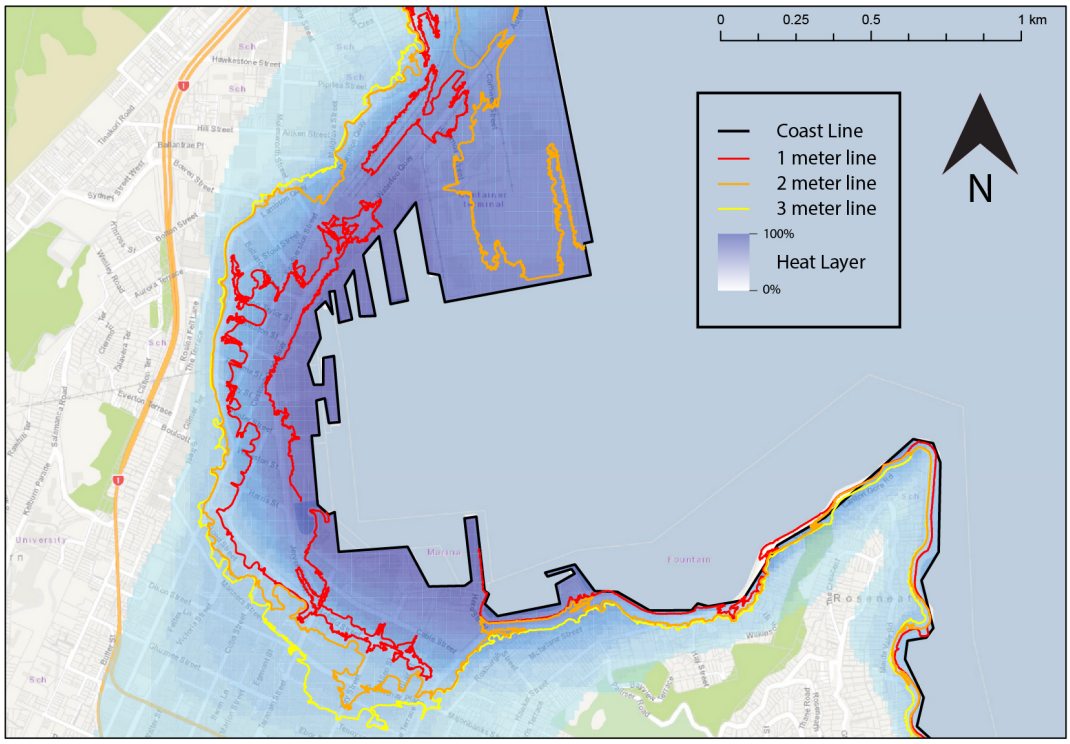

Figure 4.2: Heatmap of SLR-Impacted Areas of Wellington

1 meter line then they would be accurately identifying areas of concern. These areas of concern are primarily the immediate coast line and the lower lying regions along Lambton quay. Looking at Figure 4, it is easy to see that people shaded these regions more frequently than anywhere else on the map. Overall, the public was able to correctly identify the general extent of the areas impacted by SLR in 50 years. In summary, in conjunction with our result discussed earlier regarding participants' general awareness of sea level rise as an issue, it is clear that overall, our surveyed population has a reasonable understanding of sea level rise.

Result 2: Personal impact from SLR

The second result that we were able to gather from our convenience surveys was that overwhelmingly, respondents believe that they will be impacted by sea level rise in Wellington. This result is based on one of our survey questions which asked whether respondents

believed that they would be impacted by sea level rise in their lifetime. To this question (n = 110), 75% of respondents answered yes, 23% of respondents did not believe that they would be impacted, and 2% were unsure. Of the 23% (n = 25) who did not believe they would be impacted, 10 of them added, unprompted, that they believed future generations would be affected by SLR. A graphical representation of this data is shown below in Figure 4.3.

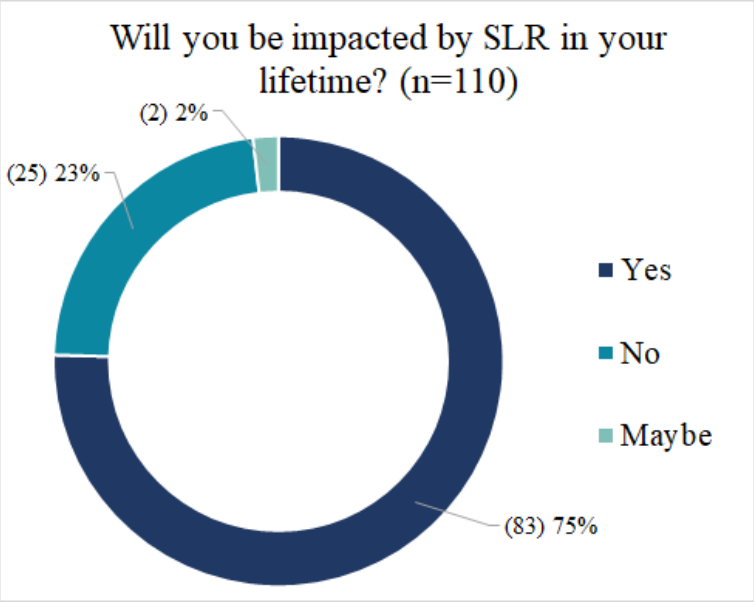

Figure 4.3: Will You be Impacted by SLR in your Lifetime?

Result 3: Misunderstanding of the SLR Projections

The team also found that the public was not able to correctly identify projections for sea level rise in Wellington. To measure this, we asked participants an open-ended question to report how much they believed sea level would change in Wellington in 50 years. Participants responded with an approximation in meters or centimeters. We coded their responses into groups (no change, 0.1-0.49m, 0.5-1.0m, 1.0-2.0m, 3.0-5.0m, greater than 5 meters, and unsure). These categories were chosen to encompass the correct projection for SLR by 2070 as well as to incorporate respondents who tended to answer in ranges such as 0.5-1 meter. We then created a graph based on these groups, which is shown below in Figure 4.4.

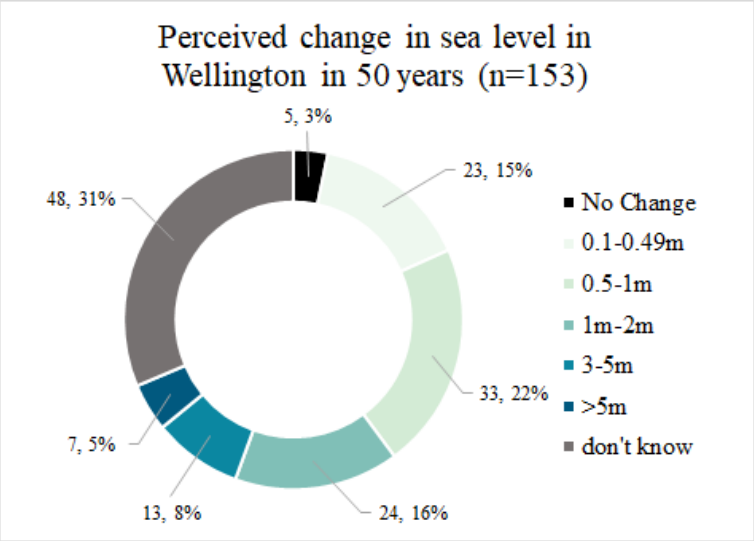

Figure 4.4: Perceived Sea Level Rise in Wellington in 50 Years

We learned through conversations with the ARC that it is generally accepted in the science community that sea level is projected to rise between 0.5 and 1 meter in Wellington in 50 years. Of the 153 survey participants, only 33, or 22%, were able to correctly identify this range of projections. The remaining distribution show that 18% of respondents underestimated, 29% overestimated, and 31% responded that they were unsure and could not make a guess. This shows a relatively even distribution across overestimating, underestimating, and correctly estimating. This demonstrated that people lack knowledge about the extent that the impact SLR will have in Wellington. This was also confirmed through observation during surveying. While just under a third of respondents were so unsure they did not want to give an answer, many respondents who did venture a guess were also visibly unsure of their answer. Between the evenly scattered responses and the large amount of uncertainty among participants, the public is not aware of the specific projections of sea level rise for the city of Wellington.

Result 4: Disparity between perceived risk and preparedness

The fourth finding we made from our surveys was that there is a distinct disparity between perceived risk and preparedness between different risk events. One of our survey

questions asked respondents to rate how at risk they felt to four different risk events: earthquakes, tsunamis, storm surge, and sea level rise. These were rated on a scale of 1-5, with 1 representing low perceived risk and 5 representing high perceived risk. Another question of the same format asked respondents to rate how prepared they felt to handle each of the same four risk events. The distribution of responses for each risk event's perceived risk and preparedness was separated into quartiles. Quartiles are a statistical analysis tool that takes the median between maximum and the minimum of a distribution, known as the second quartile, as well as median between the second quartile and the minimum and the maximum, known as the first and third quartile respectively. Figure 4.5 below shows the quartile distributions of the perceived risk and preparedness for the four risk events. The full distributions can be viewed in Appendix E.

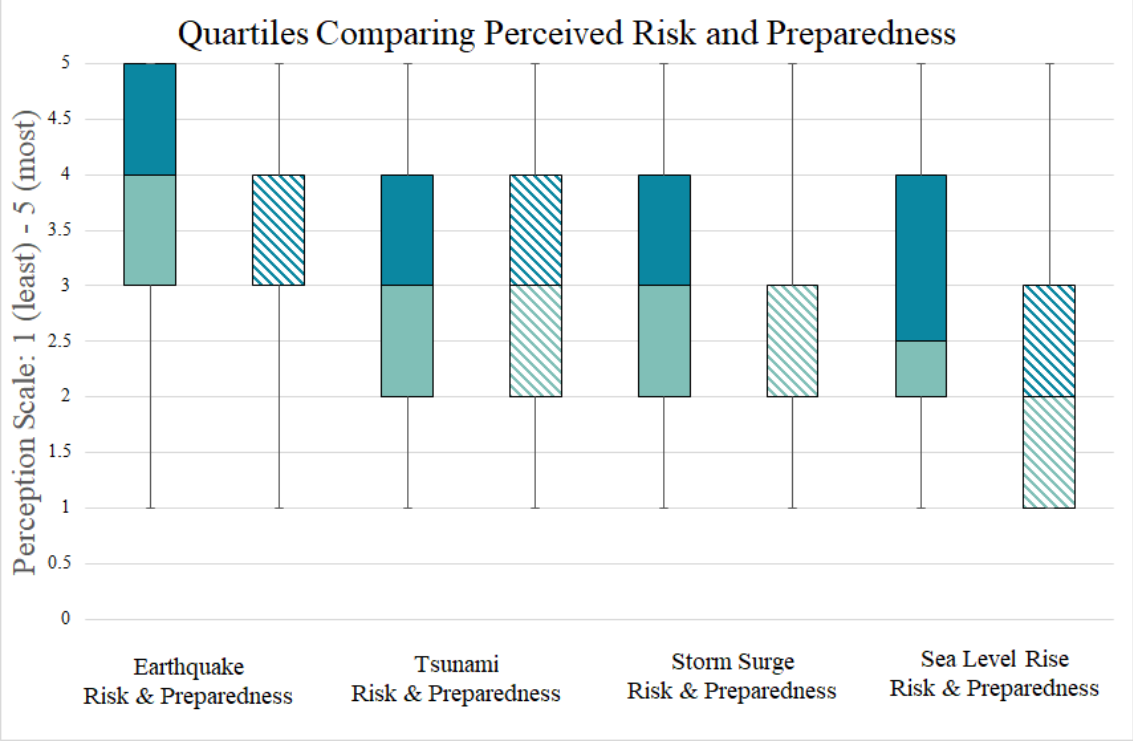

Figure 4.5: Perceived Risk and Preparedness Quartile Distribution (n = 153)

The above plot shows that the public perceives earthquakes as the most high-risk event because the quartiles are shown higher on the perception scale, with a median of 4. Tsunamis and storm surges were the second riskiest as they were both rated with a median of 3 and

had the same upper and lower quartiles. However, sea level rise was perceived as the least risky of the four events, because even though the upper and lower quartiles are the same as tsunamis and storm surges, the median is slightly lower, at only 2.5.

Not surprisingly, following a similar pattern as what we found for perceived risk, respondents felt most prepared to respond to an earthquake. The pattern held, with people reporting moderate preparedness for tsunamis and storm surge, and least preparedness for sea level rise. The most striking finding from perceived preparedness was for SLR, which had a median of 1 unit lower than the other risk events. Within tsunamis, storm surges, and earthquakes, the amount of risk that people perceived was proportional to how prepared they felt. However, there is a sizeable disparity between perceived risk and preparedness for sea level rise. This results quartile difference of one. This means that even though the public perceives sea level rise to be less risky than disasters like earthquakes, they do not feel as prepared to handle the disaster relative to the risk. The underlying significance to this result is that in conjunction with Result #2, not only is the public aware that sea level rise will be a major issue in their lifetime, but they do not feel ready to handle the event. This question also sparked side conversations with respondents as they were inspired to inquire about methods that individuals can use to prepare for sea level rise. This supports the idea that the public wants to learn how to respond to SLR.

Result 5: SLR Policy in Wellington

The fifth interesting result that we identified in our convenience surveys was that an overwhelming majority of the surveyed population believes that there should be some policy in place in Wellington to respond to sea level rise. In fact, 90% of participants responded that they believed that some policy should be enacted. Of the remainder, only 8% responded no, and 2% said they were unsure. Additionally, through a follow-up question, we became aware that of the 90% who believed that a policy would be beneficial, (n=132), 66% thought that this policy would need to be enacted immediately in order to be effective. Over 75%

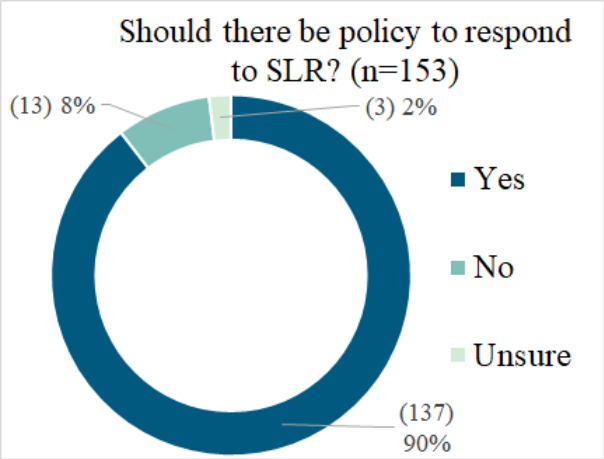

Figure 4.6: Should There be a policy enacted to respond to SLR

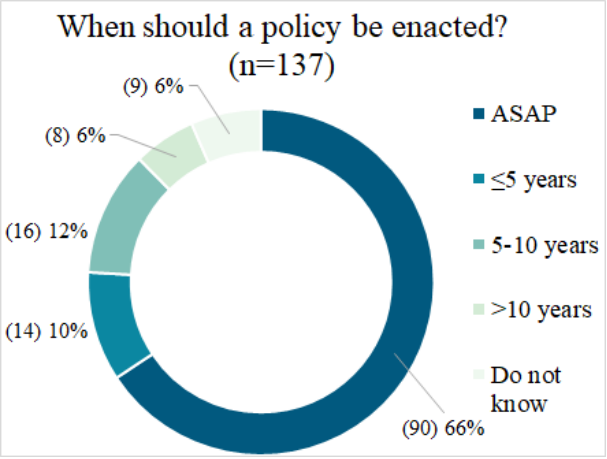

Figure 4.7: if so when?

of people believed that it would need to be enacted within 5 years in order to be effective. This corresponds to a policy being enacted within the current government. A graphical representation of this data is shown in figures 4.6 and 4.7.

It is clear here that the majority of our surveyed population believes that some policy should be enacted. Interestingly, the majority of people who wanted a policy were young. Of our respondents under 30 years old, only 2 out of 70 said no to a policy. When looking at the same numbers for respondents under 50 years old the rate that said no to a policy triples from around 2% to 6% (or 8/129). Here it is clear that the Wellington community and the younger population in particular are interested in a policy to respond to sea level rise. This result in conjunction with Results #2 and #4 shows that the Wellington population is eager to take steps towards dealing with SLR.

Result 6: Demographic Results

Initially, the team had intended on using demographics to make conclusions about how different groups of people perceive sea level rise. However, it became clear that we would not be able to make these conclusions. We did not have enough data across all ethnicities

to make any statistically significant claims around ethnic background. Additionally, we also found no correlations between our survey questions and education level. Similarly, we found no difference in responses between respondents who were in partnerships and single as well as those with and without children. For these reasons, we will not be making any conclusions based on these demographics groups. The graphical analysis of each demographic group can be viewed in appendix D.

Result 7: Responses to SLR

Another interesting result that the team learned through our convenience surveys was that the majority of our surveyed population does not know any methods to respond to sea level rise. We included a question on our pilot survey which asked respondents if they were aware of anything that they could do to protect themselves from sea level rise. Over 84% of our surveyed population responded that they were not aware of any methods. Of the remaining 16%, 7% mentioned retreat or evacuation, 7% said mitigation, and 2% mentioned building a sea wall. The team decided to remove this question from the survey after the pilot because of the overwhelmingly negative response from participants, so this metric only represents 44 surveyed individuals.

Result 8: Sources of information

The final interesting finding that the team identified was about where the public gets their information on sea level rise. One question in our convenience surveys asked respondents to list which sources have helped to inform their knowledge about SLR. Respondents were asked to cite all sources that they have used. In this question, 54% (83 individuals) of respondents cited the internet which includes social media, online news and publications, as well as general web browsing. Additionally, 38% (58 respondents) identified TV as a main source of information, which includes TV news and radio broadcasts. This aligned with traditional media coverage. The team expected this result to this question, because both of these sources

are relatively convenient to find and the information they present has a tendency to be easy to digest. Additionally, another question in our survey asked respondents if they were aware of any recent publications from the Greater Wellington Regional Council (GWRC) regarding sea level rise. Here, over 90% of respondents said they had not even heard of any of the publications. It is possible that the GWRC publications had lower readership because they did not get high visibility. This aligns with the other sources of information we identified being paper texts, including books, magazines, and newspapers, which had only 20% (30) of respondents identify. The other sources including education, word of mouth having about 15% each (26 and 22 responders, respectively). The full distribution of the identified sources of information is shown below in Figure 4.8.

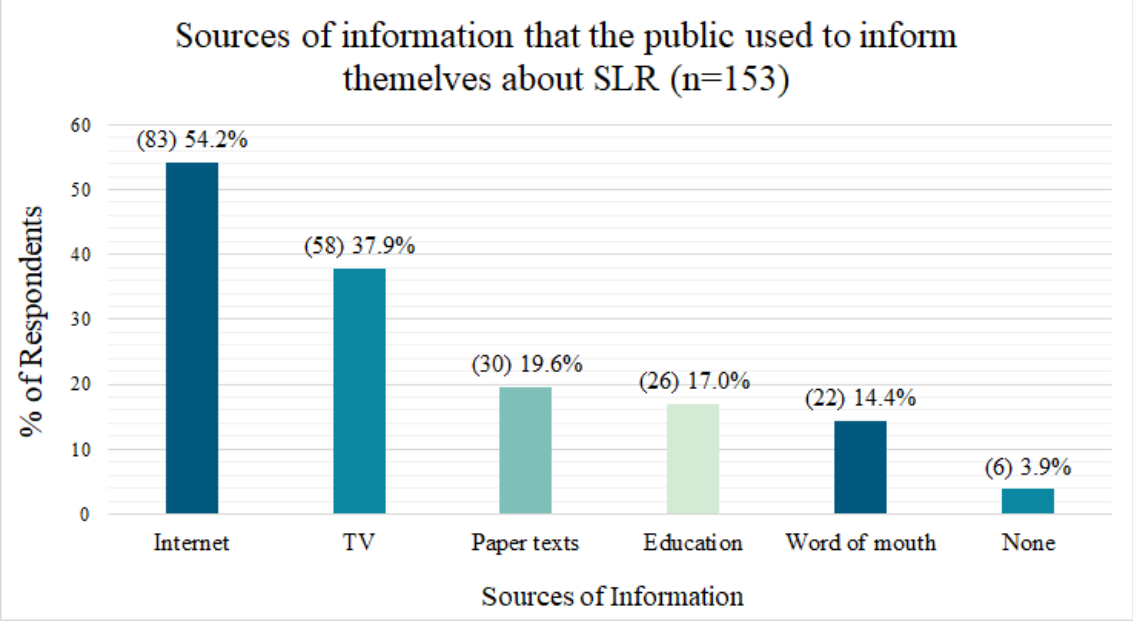

Figure 4.8: Sources of Information Distribution

4.1.2 Discussion

After identifying our results from the convenience survey as discussed above, the team then analyzed these results in the context of communicating SLR to the public. Through this process, we discovered patterns across several of our results. These patterns are discussed

Objective 1 Findings	Relevance to Science Communication
SLR preparedness is lower than perceived risk	The public is aware of the risk of SLR but does not know how they can help mitigate SLR. This can cause the public to feel hopeless because they are not able to affect change.
Public has a general but not detailed understanding of SLR	The primary goal in science communication is to create a well educated public. Therefore, there is still more information the public could learn.
Primary sources of information are the internet and TV	The information the public consumes influences their perceptions and knowledge of SLR. Common sources of information are not necessarily vetted for accuracy and can mislead the public.

Table 4.1: Objective 1 Findings

in this section as Findings. We then identified three major areas that could be targeted in future outreach by the ARC, summarized below in Table 4.1, which are discussed below.

Finding 1: The Public's Preparedness for SLR Lags Behind their Perceived Risk

The first problem that the team identified was a lack of preparedness for sea level rise in the surveyed population. In Result #4, we discussed the disparity between perceived risk and preparedness that respondents felt toward sea level rise. This is evident that respondents are concerned about sea level rise and feel that it is an idea that they are concerned about, but they do not feel prepared to respond to it. As anecdotal evidence, after administering the survey, many respondents asked us how to prepare for sea level rise, because they were not aware of any preparation methods. This is also supported by Result #7, which shows that 84% of our pilot population did not know any methods to respond to sea level rise. Additionally, of the 16% that did could identify a mediation method, over half said relocation. Furthermore, we learned in Result #5 that 90% of respondents believe that there should be a policy enacted in Wellington to respond to sea level rise, which is evidence that the public

is interested in some action being taken to prepare for SLR in Wellington. In summary, we have identified that people do not feel prepared to respond to sea level rise, and they are not aware of any methods to prepare themselves, but the public does want some policy to be enacted. Therefore, it would be beneficial if future outreach efforts addressed methods of preparation that the public could act upon.

The fact that there is a disconnect between the public's preparedness and the perceived risk for SLR can potentially be explained by the cognitive heuristics discussed in the background, 2.6. The higher perceived risk could be explained by the affect and availability heuristics. The higher risk associated with SLR could a be a result of how SLR has already been communicated to the public. For example, the affect heuristic explains that an emotional response to an event will cause them to view that event as a risky. Therefore, it is possible that the high risk of SLR could be because the public has been having a strong emotional response to the information communicated about SLR by other sources in New Zealand. This perceived risk could also have been caused by an increase in recent damaging events that have been exacerbated by SLR, as explained by the availability heuristic. The number of floods around the Wellington region has increased over the past decade (NIWA, 2017) which could have led to the idea of SLR being more prominent in their minds. Furthermore, the relatively low preparedness for SLR could also be explained by the availability heuristic. The public has never had to deal with a long term issue such as SLR before and therefore has not had to prepare for changing climate. Therefore, the public would not reasonably be aware of methods to prepare their homes for SLR because they had not been developed before the past couple of decades. Finally, the strong desire for a policy to be enacted could be partially explained by the diffusion of responsibility phenomenon. The public knows that SLR poses a threat to them, however they do not want to or do not have the knowledge to prepare for SLR. The responsibility to prepare for SLR would typically fall upon the individual, but by having a policy enacted the individuals would not have to prepare themselves, but instead rely on other officials whose job it is to prepare for SLR. The

diffusion of responsibility explains this phenomenon stating that in a group an individuals will be less likely to take action because they believe that someone else will instead. Overall, this finding can be reasonably corroborated by cognitive heuristics and makes logical sense.

Finding 2: The Public's Knowledge is Incomplete

The team identified a base understanding of sea level rise within the surveyed population. In Result #1, we discussed that when rating their awareness of sea level rise on a scale of 1-5, the median response was 3, as shown in figure #. This suggests that many respondents are aware of the idea of SLR. This finding was corroborated by a later survey question in which over 90% of participants were able to correctly identify one cause of sea level rise. Here, we show that our surveyed population has at least a basic level of sea level rise knowledge. However, this knowledge is not necessarily very detailed. While 90% could identify one cause of sea level rise, only 35% could identify two causes, and less than 10% could identify three or more causes. Additionally, we discussed in Result #3 that the public does not have a clear understanding of how Wellington will be impacted by sea level rise. When asked how much the sea level would rise in Wellington in 50 years, about one-third of the population overestimated, 22% gave the correct answer and 15% underestimated, and one-third were unsure of the projections and declined to even make a guess. Here, the team was able to extrapolate that while most of our surveyed population has some understanding and awareness of sea level rise, their knowledge is not extensively detailed. This could be a target of future outreach to improve the public's level of understanding of SLR.

The types of information that the public retains could potentially be explained by the affect heuristic. For example, the causes of SLR could have been retained because concepts such as global warming, melting ice, and pollution, are concepts that elicit an emotional response and conjure a specific image in the public consciousness. Therefore, when people feel an emotion for climate change they are more likely to remember buzz words associated than the process by which climate change occurs. Similarly, numbers such as those in

projections have relatively little physical meaning to public outside of the context of a figure or graph and therefore could be easily confused and forgotten. The numbers themselves do not have an emotional weight to them. Additionally, the fact that such a high percent of New Zealanders were able to identify at least one cause of SLR could be a result of social norming. If climate change is widely accepted by 'the average kiwi' than any individual person is more likely to agree with the status quo and also accept climate change.

Finding 3: Major Sources of Information

The team learned from Result #8 in our convenience surveys that most people learn about sea level rise from either the internet, television, or to a lesser extent paper texts and word of mouth. In fact, 95% of our survey respondents informed themselves about SLR from at least one of these sources. Additionally, less than 10% of participants had heard of or remembered any of the recent publications by the Greater Wellington Regional Council on sea level rise. Here, we can see that the public has a tendency towards getting their information from more readily accessible sources. This is an important finding to keep in mind as we begin to plan our proposed strategies.

The sources of information that the public gets their information from is very important because it influences the other two problems we have identified. A source of information controls which facts and data are disclosed to the public as well as how that data is portrayed which affects how the public feels about and interprets the data. This idea is supported by the credibility heuristic and social theory framework discussed in the background section 2.5.1. Social theory suggests that the public will align their actions to reflect how they perceive those around them acting, social norming and social comparisons. Additionally, data from Result #8 show that 54% of respondents use the internet, which has shown to exacerbate social amplification. The internet has a very large variability in which demographics visit different websites and forums which correlates to many different versions of the 'average person'. This creates many different status quos for a person to norm towards which can

create a higher quantity of individuals that would stray from the traditional media's depiction of what a New Zealander thinks. Additionally, false information is very difficult to manage on the internet which can lead to unwarranted controversy created by a small group of individuals, which can impact the credibility of factual information. Having sources of information that give the accurate information is important to ensure that the public is provided with the correct information. Therefore, it may be necessary for researchers to be more present on other platforms of information dissemination other than by word of mouth and paper publications.

4.2 Objective 2: Identify effective methods of communicating climate research that local public officials and science communication expert have utilized

We implemented interviews with local public officials and science communication experts in order to learn about effective science communication strategies that they have used. We completed seven expert interviews among six organizations and programs including; Te Papa National Museum, Victoria University of Wellington, the Department of Conservation, the Greater Wellington Regional Council (GWRC), two professors of climate sciences associated with NIWA, and a USA university. We analyzed the interviews by transcribing them all and then searched for patterns of discussion points across interviews. The transcriptions of the interviews that we were permitted to quote are shown in Appendix L-O. From our analysis of the expert interviews, we compiled a list of five best practices for communicating science with the public, which are shown below in table 4.2. However, these best practices do not exist in a vacuum. Therefore, this section discusses the best practices as found across interviews, their relation to the psychological frameworks discussed in section 2.5, and their significance to communicating SLR to the public.

Objective 2 Best Practices	Explanation
Make information easily consumable	SLR research is complex and technical. The public can only remember the information that they understand. Therefore, SLR information must be simple, short, and interesting.
Communicate uncertainty effectively	Uncertainty should be carefully discussed as either variability in data or affected by human actions.
Include positive messaging	Whenever discussing the impacts of SLR, include how the public can take action to respond.
Allow the public to come to their own conclusions	When the public is able to reach their own conclusions, they are more likely to internalize it as part of their world view and therefore act on it.
Trust	When the public trusts an information source then they are more likely to accept information that the source provides.

Table 4.2: Objective 2 Best Practices and Explanation

4.2.1 Finding 1: Make Information Easily Consumable

Through conducting interviews with local public officials and science communication experts, our team learned that when communicating facts to the public, information should be made easily consumable. The concept of easily consumable information is broken down into three criteria: the information is short and simple, the information is relatable to the public, and the information is delivered in several different formats, especially discussion-based. This allows the public to more easily understand the information being presented.

The simplicity of information was highlighted by several of our interviewees. For example, when we interviewed Dean Peterson, Head of Science at Te Papa Museum, he said, "...We want to [give the public] a very simple explanation of climate change but we want to do it in a way that then gets them interested." He further explained that the public can be overwhelmed and disinterested in the topic if the information presented is too technical. This focus on simplicity was further corroborated by our interview with Judy Lawrence, Senior Research Fellow at the Climate Change Research Institute. She similarly argued the importance of presenting information in a non-technical format because the average person in the target audience will not be able to understand otherwise. Keeping information short and simple is supported by the affect heuristic. Information that is portrayed in simple words are easier to understand and therefore easier to make an emotional impact on the reader, which they will then be more likely to remember. Similarly, information that is given in short sentences are easier to understand than long sentences.

Our interviewees also stressed the importance of presenting information in interesting and varied formats in order to engage interest in the subject matter. The presentation of information is very important because once a person is engaged they are more likely to want to try and understand the information presented and therefore retain more of that information. One way to engage the public is to accommodate different learning styles. People tend to have strengths in learning in different ways, and communication is done most

effectively when the information presented aligns with that person's learning style. Therefore, by providing information is several mediums, the likelihood of one of those mediums aligning with an individual's learnings style is much higher. Dean Peterson discussed Te Papa's methods to engage the public when he said, "We also want [the exhibition] to be very interactive, we know that people do not really learn things by when you show them. We can just show them stuff and you know, even beautiful graphs and beautiful visuals. But if they are not actually connecting or doing, they will not learn as much so it's really important to make it social." Dean Peterson also identified several different methods the museum uses to inform the public, including visuals such as graphs and images for visual learning, hands on interactive exhibits for tactile learners, and discussion and auditory exhibits for auditory learners. Fostering public discussion of the information presented to them is supported by the social amplification heuristic. When a group of people discuss a topic and a consensus begins to form, individuals will match their own opinions with those around them, known as social norming. Social norming that takes place in-person potentially has a stronger impact than social norming that occurs over the internet due to the added benefit of face-to-face interaction.

Another interviewee agreed with Dean Peterson's sentiments about engaging the public. Her preferred style of communicating sea level rise to the public was through nonfiction writing. She believes that it allows readers to connect emotionally with scientists and researchers. She said, "I'm very much developing the scientists as characters and talking very much about the process of science that I hope would make readers who invest in reading such a long story [get] insights into the way that science is done." This interviewee believed that by making the scientists more relatable as characters, the readers would form an emotional bond with them. This would lead the readers to be more receptive to a scientist's story and their research and therefore also sea level rise. This is supported by the credibility heuristic. If the public thinks of scientists as regular people and they can better understand their goals and aspirations, the public is then more likely to trust them and their information, which is

discussed more in depth in the fifth finding of this section. By using multiple mediums to communicate, these experts have experienced success in reaching their target audiences.

Making information easily consumable is important for communicating SLR because SLR research is very technical and complex. Researchers tend to overestimate the technical understanding of the public and use concepts that the public does not understand. This reduces the amount of information the public retains. Therefore, ensuring that SLR research is short and simple, is delivered through a variety of methods, and is relatable to the public, is imperative in effective science communication.

4.2.2 Finding 2: Communicating uncertainty

Several of the communication experts that we interviewed also discussed the significance of the connotation of the word "uncertainty". To scientists and researchers, uncertainty is a probabilistic term used to describe an acceptable range which accounts for some small amount of error. However, when the public hears the word uncertainty, they associate it with a lack of confidence. Therefore, when climate change researchers communicate about uncertainty regarding levels of sea level rise, it is perceived by the public as those scientists being unsure of their research. It is important that scientists instead use the word "variability". Variability effectively communicates the range of error within SLR projections, but does not have the negative connotation that comes with "uncertainty".

Communicating uncertainty has been shown to be a difficult issue to address in the science communication community. This has shown partly arise from a disconnect between experts understanding of uncertainty as probabilistic and the public's understanding as a measure of competence. The uncertainty principle is a subset of the credibility heuristic that corroborates the idea that the public understands uncertainty as a way to judge how confident researchers are and therefore how much attention the public should give the researchers. The problem then arises because researchers need to accurately portray uncertainty in their models and projections, but in a way that imparts confidence in the public.

There are several potential ways to address the issue of communicating uncertainty. One way discussed by Rob Bell of NIWA was to use variability instead of uncertainty because this word suggests that the uncertainty is part of the environment itself as opposed to caused by the researchers. Another way to address this issue is to explicitly state that uncertainty is partially due to how humans may change their actions and therefore influence the future. This demonstrates to the public that their collective actions have a measurable impact on the future.

4.2.3 Finding 3: Positive versus negative messaging

Positive and negative messaging addresses how information is presented to the public. Positive messaging focuses on communicating solutions and aspects of a problem that can be solved - positive actions that can be taken - whereas negative messaging highlights how bad a situation is to generate an emotional response. Positive messaging is a way to get people to feel empowered whereas negative messaging is a way to galvanize people into taking action. Utilizing positive messaging instead of negative was a recurring topic that was discussed by several of our interviewees.

Four of our seven interviewees stated that the public prefers to believe that there is still hope to help a situation, no matter how dire it is. Dean Peterson warned against negative messaging in his interview. While discussing how Te Papa chooses to present inconvenient truths, he said, "People switch off because they feel like they cannot do anything. 'It's too big, it too massive. I cannot make a difference. Why do I even bother?' And of course, if everybody takes that attitude then they will not make a difference." He continued on to describe how Te Papa has to be very careful with their climate change exhibits in particular, because it is very easy for the museum to inadvertently frame climate change as an impending disaster with little hope of changing, which can cause people to ignore information. Another one of our interviewees, who preferred to remain anonymous, agreed with this sentiment. She said, "I did learn that positive messages were more useful than negative messages.

That talking about changing social norms was more important than saying do not do this bad stuff." Through these, we learned that people will be much more receptive to science communication if they feel that they are able to take some action to help the situation.

Negative messaging is a term commonly used in conjunction with the affect heuristic. Both address the idea that eliciting an emotional response, especially a negative response such as fear, is very effective motivating people to combat an issue. However, people can become desensitized to this type of messaging, which can actually become counterproductive. This phenomenon is known as environmental numbness. Discussing exclusively the negative impacts of SLR can cause the public to feel hopeless about their situation and therefore lose interest in trying to enact change. Therefore, positive messaging is imperative to use in tandem with negative messaging. Positive messaging is the term for addressing how the individual can affect change and how they are important to addressing the problem. This make sense because if people are motivated to address an issue and they are aware of methods to help, then they will be willing to take action. Therefore, when addressing SLR as an issue, it is imperative to address policies or initiatives that people can support. This will give people some motivation to help these initiatives achieve greater success.

4.2.4 Finding 4: Framing the Public's Conclusion Making

Three of our interviewed experts also highlighted that an effective method to make the public think in a particular way about a topic is to have them come to the conclusion themselves. The experts choose to do this by presenting the facts to their reader in a methodical manner with the intention that ensures the reader will come to their own conclusion, but each reader will come to the same conclusion each time. One interviewee stated that she preferred this style, "So that the reader will come to the conclusion before I tell them. So that they'll get a bigger a-ha moment. 'I see what's happening. I see. Oh yeah. That's all gonna melt, and the sea level is gonna rise. Right. I get it.'" Dean Peterson from Te Papa also mentioned the museum follows a similar logic. "We want to make it so that you

always come up with the same conclusion no matter who you are... It's a subtle thing." By giving people "that a-ha moment" they are more likely to take ownership of the idea and incorporate it into their world view. By coming to the realization by themselves, people are more likely to internalize the conclusion than if they were told it by someone else. The public is more likely to trust their own judgement than the judgement of others.

Having the public draw their own conclusion about SLR makes sense in the context of the credibility heuristic. Individuals are more likely to believe information sources that they trust, discussed in the next section, and an individual trusts no one else more than themselves. Therefore, when an individual comes to their own decision about how SLR will impact themselves and their community, they are likely to have ownership of that idea, and feel a personal connection to the topic. This could create a more active and involved public, which is one of the goals in communicating SLR to the public.

4.2.5 Finding 5: Trust is key

The final finding that became apparent through our interviews is that trust is imperative for any science communication to be effective. Individuals need to trust any source before they are willing to accept what that source says is factual. This is something that Dean Peterson highlighted, saying, "We've done quite a bit of survey work in the past and we know the public trusts us, what we say they believe is real and truthful so that's really important that we continue that." Once an organization has the public's trust, that organization can then communicate their findings, which the public will be more likely to accept.

Trust and credibility was already discussed in depth in background section 2.6 as part of the credibility heuristic. This heuristic explains that when an information source has proven itself to be reliable and align with the interest of the public, individuals are more likely to accept results than from sources that are perceived to be unreliable. A reliable source can be defined as an organization that has shown to be virtuous in its goal, such as the pursuit of knowledge and educating the public, as well as to connect to the public on a personal level.

SLR communicators and SLR researchers in particular need to be trustworthy because they are the authority on climate change and SLR. If they are perceived as being untrustworthy, then any association they have with the topic may tarnish the image.

4.3 Objective 3: Design communication strategies to effectively communicate sea level rise to the public based on findings from Objectives 1 and 2.

This section presents findings from the team's ideation of potential communication strategies to propose to the ARC based on our findings from Objectives 1 and 2. In our primary ideation step, we generated 50 possible ideas through the ideation process as outlined in our methodology. This included individually brainstorming outreach strategies onto sticky notes. Then, we met as a group to discuss each idea so that each team member understood what the outreach strategy entailed. We then brainstormed as a group on each idea to expand and explain how each outreach strategy could be implemented. Once ideation had concluded, we sorted them into seven themes: Art Installations, Public Events, Website, Social Media, Publications and Signage, Methods to Increase the ARC's Name Recognition, and Simulation. The team analyzed each of these groups through SWOT analysis, as discussed in our methodology, and four groups of ideas emerged that we believe would be the most successful if implemented by the ARC. The four ideas were: creating a New Zealand-specific simulation, creating a website containing a compendium of sea level rise information, fostering a social media presence, and partnering with the city to create an art installation. This section discusses each of the four identified groups in detail, why each was chosen, and how each address the findings from Objectives 1 and 2.

4.3.1 Simulation

The first strategy that the team discussed was to create an online simulation that allows the public to model how their decisions could impact sea level rise in New Zealand. To be most effective for reaching the Wellington and New Zealand public, the simulation should be tailored locally to the country of New Zealand. The simulation would allow users to model different IPCC Representative Concentration Pathway (RCP) scenarios, from present day to the year 2100. Through these scenarios, users would be able to see how different levels of carbon emissions affect the sea level around New Zealand. Such a simulation could also include options to display different contributing factors to sea level rise. This would include selection buttons to account for ice melt from glaciers and the Antarctic Ice Sheets (AIS), thermal expansion, and geological factors. By including the different contributing factors to sea level rise, users would be able to gain additional knowledge about how each factor contributes to the total SLR. Additionally, there would be multiple functionalities of the simulation for demonstrating the impact of SLR on New Zealand. Potential impacts of interest could include geographic land loss from SLR, the relative increase in frequency of flooding from storms to different areas, and areas prone to salt water inundation.

Current global simulations of climate change tend to lack the level of detail required to adequately account for region specific variability in SLR such as the subversion of land due to tectonic plate movement. This New Zealand specific simulation could become a product from the SeaRise Programme which seeks to make projections specific to New Zealand based on collaborations from numerous organizations as discussed in the background section 2.3.2. An example of the simulation user interface is shown below in Figure 4.9.

The team identified simulations as a potential strategy to address our second result from Objective 1, which stated that the public is generally unaware of specific sea level rise projections in Wellington. Through exploring this simulation, users will gain a clearer idea of how the sea level will rise in the coming years, with different environmental variables

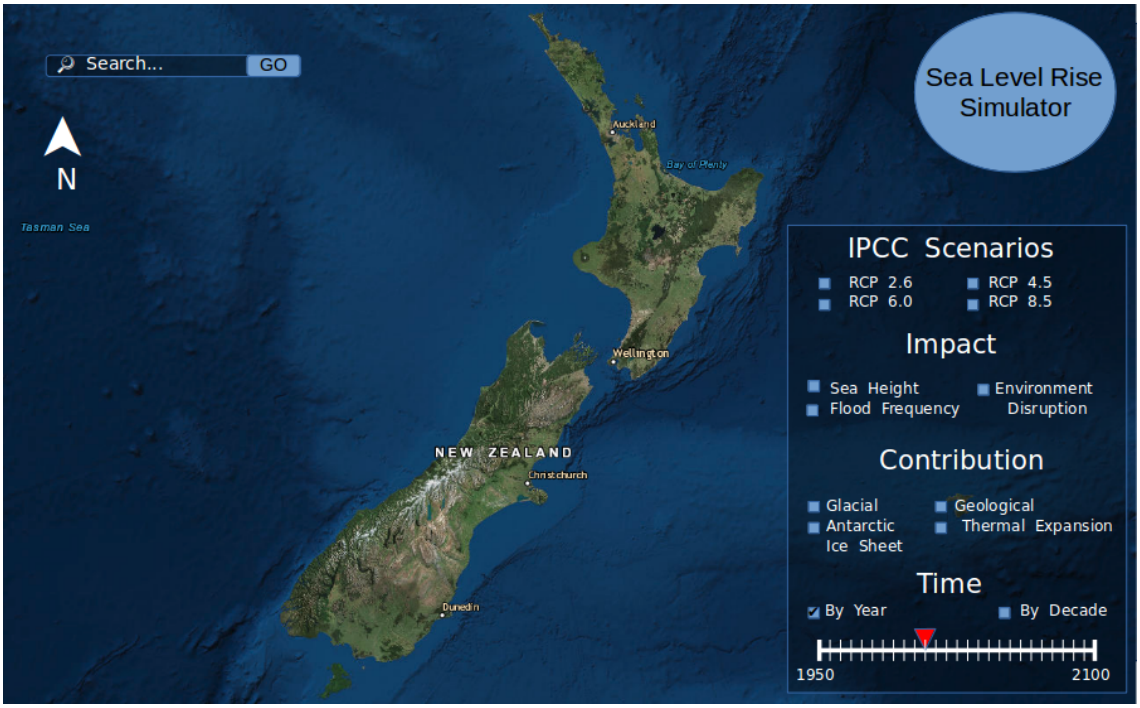

Figure 4.9: New Zealand Specific Climate Change Simulation

like the IPCC scenarios. Additionally, this strategy would also target the first finding from Objective 1, which was the disparity between the public's perceived risk and preparedness of SLR. To address this finding, the simulation would guide users through making smart climate-related choices by explaining how human actions have contributed to each of the IPCC RCP scenarios. In order to provide specific methods to help the public feel prepared for SLR, an extra layer could be included that provided different response methods, such as a sea wall. Users could place a sea wall around an area and visualize how that method would impact flooding in the area. Lastly, this simulation also addresses our third finding from Objective 1, which was that people get their information on sea level rise from many sources, not all of which are credible. Providing an accurate simulation of SLR's impact on New Zealand would help to offset less-than-credible sources, especially on the internet.

Live-action simulations had been discussed by several of our expert interviewees as successful outreach strategies that they had used in the past. For example, Judy Lawrence spoke in detail about the success she had experienced as she led many local public officials through

a live-action simulation on sea level rise and making climate-related policy decisions based on predetermined SLR scenarios. Our suggestion would expand upon Judy Lawrence's simulation by providing online access which would allow the public to investigate the simulation at their leisure. Also, our suggested simulation would account for recent data collected and changes in SLR projections for New Zealand. The SLR simulation would also address the best practices from Objective 2 about communicating the uncertainty of SLR, as it would allow the user to explore the variability between projections based on IPCC scenarios. This simulation addresses another point that Dean Peterson made about making information as interactive as possible. In this simulation, users will have to manipulate the simulation in order to explore the different outcomes, which will help to increase information retention. Also, this strategy allows users to understand the negative impacts of sea level rise such as by experiencing the effects of the worst-case IPCC scenario, RCP 8.5, in a safe space, but also gives hope by showing the projections of best-case RCP 2.6. Since this is a simulation, the public will be able to visualize each of the negative impacts of these scenarios without directly having to put their property or their community in danger by waiting for SLR to impact their lives. For these reasons, the team believes that a simulation is one potential outreach strategy that the ARC should explore.

A SWOT analysis was then conducted to expand upon the advantages and disadvantages of a SLR simulation, a summary of which is shown in Figure 4.10 below. Overall, a simulation of this kind would provide several advantages to the public. Among other strengths, a SLR simulator would make it possible to help educate the user about different aspects of SLR. By delivering accurate data specific to New Zealand with a carefully designed graphical user interface, people would be able to see a visual representation of SLR, and how it will impact specific areas. Moreover, this tool would help the user in decision making that requires information about the future predictions of SLR, such as buying a house. Somewhat paradoxically, conveying uncertainty is both a strength and a weakness for the simulation. The simulation can easily depict different, discrete projections; however, it is difficult for a

simulation to show probabilistic uncertainty visually on a map.

Furthermore, we recognize certain weaknesses with this design of the simulation that should be taken into account. For instance, developing a software simulator would require investing a large amount of time and requires large amounts of very accurate and detailed data in order to precisely model SLR. The SeaRise programme plans to make New Zealand specific projections for SLR, therefore, ideally, much of the data is already planned to be collected. Additionally, appropriately presenting the uncertainty (or variability) of future predictions can potentially become a challenge during the development of this software, since it needs to be shown to the user in a very clear and straightforward manner.

Finally, after analyzing different opportunities and threats for this design, we realized that this SLR simulator could also be used as a teaching tool for other organizations to inform them about best practices to make similar simulations for other potential uses. Additionally, if the software is designed correctly, it could continue to grow and include new impacts of SLR in the future. For example, other impacts such as salt-water intrusion could be later added to the software. We also concluded that one potential threat inherent to the platform on which simulator would exist could leave the simulation to be hacked and information could be modified. However, the likelihood of this occurring is fairly low. Additionally, as new information about climate change is discovered the information in the simulation may become outdated and no longer accurately portray scientists' understanding of SLR and therefore need to be updated. Finally, the simulation might panic those who utilize it.

4.3.2 Social Media

The second strategy that the team discussed was to create a stronger social media presence for the ARC. A social media campaign would have the potential to increase the quantity of people who consume SLR information from the ARC, and also could better connect the ARC to the public. Although the ARC already has a Facebook page, it is rarely updated. Our team believes that a revamp of the ARC's social media presence would be beneficial.

SWOT Analysis of Designing a SLR Simulation

Strengths

- Visual representation of SLR
- Models variability, IPCC scenarios
- Models time
- Focuses on accuracy in New Zealand
- Multiple layers to indicate various impacts of SLR
- Addresses objective 1 findings: more credible sources of information, further education of SLR topics, and increase public preparedness

Weaknesses

- Less accessible to the public due to high quantity of information
- Requires large time investment to develop
- Requires a large quantity of accurate and detailed information
- Difficult to model uncertainty

Opportunities

- Can be used to demonstrate localized impacts of SLR
- Can be used as a teaching tool for other organizations
- Can be expanded to include more impacts of SLR such as salt water intrusion

Threats

- Can potentially be hacked and information could be changed
- Information could become out of date
- The projections could cause the public to become panicked by SLR

Figure 4.10: SWOT Analysis of Designing an SLR Simulation

This revamp would target three main social media platforms: Facebook, Instagram, and YouTube. The Facebook page should be used primarily to communicate research findings, important events, and relevant climate change related news to followers. Additionally, the Facebook page would be used to direct new followers to other areas of the ARC's online presence. An Instagram page should be used to share researcher biographies as well as updates on Antarctic expeditions. The biographies will make the researchers more relatable to the public, and the updates will help the public to better understand the ARC's research. An example of a potential Instagram post is shown below in Figure 4.11. Finally, we suggest that the ARC create a short series of YouTube videos to describe the research behind SLR, the impacts of SLR on Wellington, and ways to prepare for SLR. This video campaign could

be advertised using the ARC Facebook page to gain additional visibility. We believe that with this three-pronged approach, the ARC would be able to maximize the potential benefits of a social media campaign.

Figure 4.11: Example Instagram Post

Utilizing this social media strategy would address the three findings we identified in Objective 1. First, it would address the first finding by providing explaining what the major methods to respond to SLR are in the Youtube series. Additionally, this strategy addresses our second finding, which was that we know the public's base knowledge about SLR, but we do not know how detailed their understanding is. Through the educational YouTube

series, this strategy would be able to build upon the public's understanding of sea level rise, and help to increase their amount of detailed knowledge. Additionally, this strategy also addresses our third finding, which stated that the public seeks their information on sea level rise from many sources, one of the most prominent being the internet. The internet inherently has many purveyors of information, not all of whom are credible. This campaign would provide a scientific voice of truth on the public's social media feeds, which would be beneficial in combating less credible sources.

The team also identified social media as a method to address several findings that had been mentioned during our expert interviews in Objective 2. One such finding from one of our experts was to make the researchers and their science more relatable to the public. This is the main goal of the Instagram posts. By posting biographies on researchers and updates on their work and expeditions in the Antarctic, the ARC would become more relatable, and this could make the public more interested in the work that they are doing.

Through our SWOT analysis, we also identified some weakness that are inherent to a social media campaign. Social media requires time to attract a large number of followers and is hard to maintain. An entire area of study and many professional careers have been dedicated to perfecting algorithms of social media influence. However, there is an opportunity for the ARC to hire an intern or student worker who is excited about this recommendation to organize the ARC social media presence. This would allow the ARC members to continue to focus on their research. There is a large potential audience for the ARC on social media, and we believe that the ARC should attempt to communicate with them through their preferred communication platform. A summary of the SWOT analysis we used to assess the potential effectiveness of this strategy is shown below in Figure 4.12.

4.3.3 Website

The third strategy that the team identified was a compendium website of sea level rise information. This website would contain relevant information about sea level rise, with a

SWOT Analysis of Social Media Implementation

Strengths

- Increases the ARC's presence and name recognition
- Instagram: shows that researchers are also people
- Facebook: platform for growing the ARC's following
- Addresses objective 1 findings: more credible sources of information, and further education of SLR topics

Weaknesses

- Social media presence is hard to maintain
- Requires time to produce a large following
- Hard to differentiate amongst the large volume of information provided on social media
- Does not address the objective 1 finding to improve the public's preparedness for SLR

Opportunities

- Large potential audience
- Hire a student worker to manage social media
- Facebook: platform for sharing publications, news, and related articles

Threats

- There are so many sources of information on social media, it can be very difficult to establish a presence at all.
- The credibility could be questioned amongst other websites that disseminate false information

Figure 4.12: SWOT Analysis of Social Media Implementation

focus on its effects in the Wellington region. The purpose of the website would be predominantly informational with several tabs containing different types of information. The website would provide educational tabs explaining what SLR is, how SLR would impact New Zealand, and information about methods local research organizations are using to respond to sea level rise as well as what the public can do on an individual level. The website would also include a news feed which would be updated regularly on new developments in the climate change field such as the publication of a new IPCC report. Additionally, the website would contain a calendar of local climate-related events that users could attend such as panels or conferences. Furthermore, this website would contain links to other relevant websites, such as climate research organizations such as NIWA, the GWRC, or even to the simulation,

as described in section 4.3.1. It would be imperative that this website be created with an intuitive, user-friendly design so that it could be used effectively by the public. An example of what tabs of information would be included on the website is shown in Figure 4.13 below.

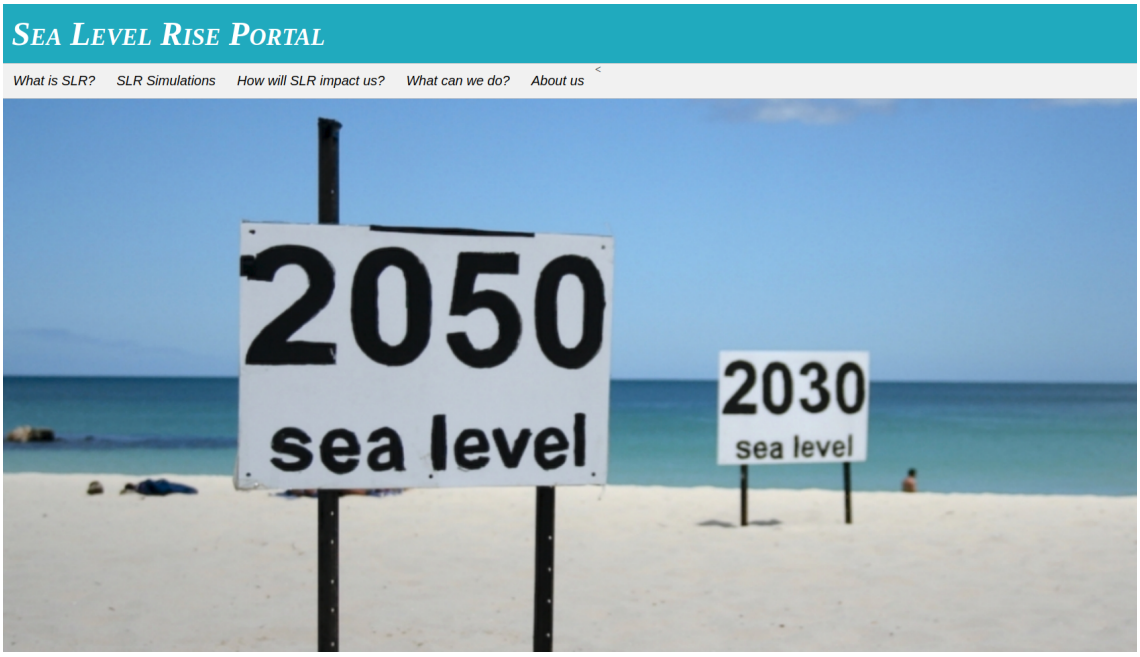

Figure 4.13: Example of a Potential Website Frontpage

Similar to the proposed social media campaign discussed in section 4.3.2, this outreach strategy would provide a credible source to direct the public to if they are interested in learning about SLR. This strategy also addresses our first finding from Objective 1, which discussed that there is room for the public to improve their sea level rise knowledge, by giving examples of how Wellington city can prepare for SLR and how an individual can do their part to mitigate climate change. Finally, the website inherently addresses the second finding by including information about SLR as well as IPCC projections. By providing the ARC with this all-encompassing portal, the public would have one easy-to-use resource to gain knowledge about sea level rise. However, we identified some weakness that should be addressed. The first weakness and threat is that the user interface (UI) for the website needs to be meticulously designed because a poorly designed UI can cause the public be reluctant to use the website. A well-designed UI should be intuitive and easy to follow. Another

potential weakness is that similar to social media, getting people to view a website is hard and there exists another entire field of study devoted to understanding how to increase traffic to a website. Therefore, we suggest that collaboration between numerous organizations to use a single climate change portal can increase traffic to all collaborators. For example, if the GWRC, the ARC, and NIWA collaborated on a website they could combine their viewerships to ensure more of the public accesses their combined knowledge about SLR.

After conducting a SWOT analysis, we found that this strategy counts on multiple strengths to make effective outreach. For instance, besides increasing the public's preparedness and education on SLR, it is also shared through the internet, a very popular platform that most people get information from. Moreover, it helps the ARC increase their name recognition and online presence by giving them the opportunity to share new developments in the field of climate change. Parallely, one of the advantages of this strategy is that it can address different questions that might be of interest to the public, such as possible solutions or how to prepare for SLR.

Finally, we devised assessed opportunities and threats that a SLR website would allow. For example, one opportunity is that this approach can open the doors to potential collaboration between organizations, and it would also establish a direct link of communication between such organizations and the public. To some extent, this website could potentially become a centralized hub for all the information about SLR in New Zealand. However, it is imperative to say that one of its weakness lays on the platform where this method is built on, as it could be potentially hacked and the information manipulated. A summary of the SWOT analysis we used to assess the potential effectiveness of this strategy is shown below in Figure 4.14.

4.3.4 Art Installation

The fourth and final outreach strategy that the team identified was an art installation. This would be some visual representation of sea level rise that we would like to be displayed

SWOT Analysis of Creating a SLR Website

Strengths	Weaknesses
• Increases the ARC's presence and name recognition • Multiple pages to address any questions the public might have for SLR • Links to other organizations such as the GWRC. • Contains a newsfeed of new developments in the climate change field. • Addresses objective 1 findings: more credible sources of information, further education of SLR topics, and increase public preparedness.	• Careful attention to design required to create a usable interface.
Opportunities	**Threats**
• Collaboration potential among many organizations. • Direct communication between organizations and the public. • Create a central location for all information regarding climate change in New Zealand.	• Can potentially be hacked and information could be changed • Hard to acquire views and generate traffic on the internet due to a high saturation of potential websites to visit. • The credibility could be questioned amongst other websites that disseminate false information

Figure 4.14: SWOT Analysis of Creating an SLR Website

in high-traffic areas of the CBD in order to be as highly-visible as possible. The goal of this type of strategy would be to trigger an emotional response in viewers. One possible strategy that we brainstormed was to create several human-sized plastic water bottles, and place them in clusters of four in various spots around the CBD. The bottles would appear to be filled with a liquid to represent the projected sea level rise in 100 years based on each of the four IPCC projections. This installation intentionally represents all four IPCC projections, because this will show the public that there is a chance to do something about sea level rise, but also to remind them that if nothing is done, the consequences are severe. Additionally, a plaque or sign would accompany the installation to explain the what impacts for each the

projected SLR for each scenario would be on New Zealand, how human actions caused each IPCC scenario, and provide resources that the public could visit to find more information about SLR such as the website discussed earlier in this section. A SketchUp model of the art installation is shown below in Figure 4.15.

Figure 4.15: Sketch-up of Water Bottle Art Installation

This method addresses several of the points that were discussed in Objective 2. This strategy would raise the public's awareness on SLR because the installation would have a very simple and clear message as well as connect emotionally to the public Additionally, the art installation addresses the first finding in objective 1 by providing more detailed information on the projections of SLR and therefore providing more detailed knowledge. Furthermore, this strategy would allow the ARC to communicate to the public through a different medium than the internet or through publications. By creating an art installation, the ARC targets a new area of public information, word of mouth. However, this strategy does not explicitly address the public's perceived lack of preparedness and in order to address this finding, the installation would need to direct the public to other resources.

There are opportunities as well as threats that our team has identified if the ARC were to implement an art installation. One threat that we identified was that an art installation

requires a significant time and money investment to design, build, and implement. An art installation would also require the ARC to submit applications, get permits, and go through the permissions process. The ARC has contacts with several of the governing bodies of Wellington which could expedite this process, however, a considerable amount of planning would be required complete. One potential opportunity would be to collaborate with local artists and organizations that have created art installations in the past in order to gain inspiration and advice on how to implement this art installation. Furthermore, the art installation could last a very long time which is beneficial because the installation could impact people over several years. However, the projections could become outdated as new climate change data for New Zealand becomes available. In order to account for new projections, the installation would have to be updated. Finally, an art installation could become the target of graffitti, however, this is a relatively low risk, especially in Wellington, and should only be addressed if the need arises. Overall, a summary of the SWOT analysis we used to assess the potential effectiveness of this strategy is shown below in Figure 4.16.

SWOT Analysis of Creating an Art Installation

Strengths

- Visual representation of SLR
- Demonstrates physical differences in IPCC scenarios
- Creates an emotional response
- Visually appealing
- Addresses objective 2 findings: more positive messaging, representing uncertainty in an understandable manner

Weaknesses

- Does not address the objective 1 finding to improve knowledge about SLR

Opportunities

- Long lasting method to demonstrate impacts of SLR
- Collaboration with local artists and organizations
- Creative outlet for individuals

Threats

- Requires time and money to create
- Need to submit applications and get permits to create an installation
- Projections could become outdated
- Graffiti could alter the meaning of the installation

Figure 4.16: SWOT Analysis of Creating an Art Installation

Chapter 5

Recommendations and Conclusion

Based on our findings and analysis from surveying the public and interviewing experts, we have developed a set of recommendations for developing future public science communication efforts by the ARC. We have also developed a set of recommendations to direct further exploration of public understanding of sea level rise.

5.1 Recommendations for future outreach efforts

Our team has developed a series of outreach recommendations for the ARC. These are discussed in detail in section 4.3. In addition to these recommendations derived from our third objective, we are also making additional suggestions to the ARC. The first additional recommendation is to increase the ARC's publicity and name recognition in the general public. As discussed in Finding 5 of Objective 2, it is imperative for the public to trust a source of information in order for them to accept any of the information that they are dispensing. There are already many communication and research organizations in the Wellington area that the public knows and trusts, such as Te Papa Museum, DoC, and NIWA. The trust these organizations have fostered with the public makes it easier for them to disseminate information. Additionally, by partnering with these organizations that generate more media presence, the ARC can increase its name recognition. Along with becoming a trusted

organization by the general public, increasing the name recognition of the ARC would help future outreach attempts greatly. One of the greatest obstacles in trying to communicate new information, aside from how to present it, is getting the public to first see the information. By increasing the public's awareness of the ARC and their research, future outreach attempts can be greatly improved because the public will be more aware of the ARC and therefore be more likely to be interested in the information and consume it.

To do this, we are recommending that the ARC work with other local organizations, such as those listed earlier, because if the public sees signage bearing the ARC's name in tandem with one of these other trusted organizations, they will be more likely to become familiar with and trust the ARC as well. One potential opportunity for this would be for the ARC to become involved in the new climate change exhibit at Te Papa. Additionally, the ARC could partner with Te Papa to host a one day event that focuses on ice coring and expeditions to the Antarctic. We recommend that the ARC seek out opportunities to partner with other organizations that public already knows and trusts in addition to any of the outreach strategies suggested in section 4.3.

Secondly, we suggest that the ARC completes a follow-up assessment and evaluation of the suggested outreach strategies discussed in objective 3. This evaluation would specifically investigate the feasibility for the ARC to implement each of the outreach strategies. In particular, we suggest that the ARC further investigate the specific implementation of the art installation. This could include having a separate group, such as the graphic design department of Victoria University of Wellington, design or expand upon the ideas proposed in this paper.

5.2 Recommendations for further exploring public understanding

The recommendations made in this section are based upon our analysis of the data collection through our convenience survey. The survey we used was designed to broadly establish a profile of the average person's understandings and perceptions of sea level rise. While the survey was able to gather that information in a broad sense, future data collection would benefit by more precisely probing people's level of knowledge. By more accurately assessing the extent of people's knowledge, outreach attempts can be tailored to further address the information needs of the public.

Similarly, future data collection could explore different methods for learning more about the source from which people get their information on sea level rise. As shown in the findings of objective 1, it is clear that news outlets and the internet are the most frequented places where people learn about climate science; however, both these resources are very broad. Learning the exact websites and news outlets that people learn from in more detail would further improve methods for communicating climate research, beyond the recommendations here.

Lastly, we highly encourage future data collection efforts to explore how much individuals need to know about sea level rise in order to constructively contribute to the public discussion on SLR. Exploring this would greatly help outreach efforts by more clearly defining the extent of information that needs to be communicated to the public for behavior change to occur. If people only need minimal knowledge, or on average already possess the knowledge they need, then outreach efforts can be shifted from improving education to increasing public involvement.

5.3 Conclusion

The goal of this project was to present the ARC with recommendations to improve their current communication of SLR information to the public. By accomplishing our three objectives, we were able to provide the ARC with three deliverables: an analysis of the public's knowledge and perceptions of sea level rise based on our survey data; a list of best practices in public science communication based on our interview data with communication experts; and a list of several potential outreach methods based on the findings from the first two deliverables. In conjunction with the deliverable, we also developed additional recommendations for further exploration of the public's perceptions and understanding of sea level rise that will help with future more in-depth studies on this topic, discussed in section 5.2.

With more information about the public's understanding of sea level rise and with a set of good practices for disseminating information to the public, the ARC can improve its effectiveness in sharing their research with the public. Due to the time sensitive nature of sea level rise, arming the general public with the knowledge they need to deal with sea level rise has never been more important. Taking steps now to improve the effectiveness of science communication is imperative for mitigating the impacts of sea level rise before it is too late.

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Appendix A: Convenience Survey Iteration 1

Hello, would you be willing to participate in a 10 minute survey about sea level rise? We are a group of students from an American university called Worcester Polytechnic Institute. We are conducting a research project which will be published through our university. Our goal is to research the public understanding of sea level rise, in order to improve public communication of new environmental information. Therefore, we would like to know what you know about sea level rise in Wellington. Your participation is voluntary meaning you do not have to participate and you can skip any question you feel uncomfortable answering. We will only be using personal information to understand the demographic distribution, we will not be publishing any identifiable information. Do you have any questions about this survey?

What is your gender identity?

Male Female Other

What is your age?

19 or younger 20-29 30-39 40-49 50-59 60-69 70+

What is your ethnic background?

European Pacific Peoples Maori Asian Other_____

What is your relationship status?

Single In a Partnership Other

Do you have children?

Yes No

What is your highest level of education?

Do you live in the Wellington region? If so, what suburb?

Why are you visiting the Central Business District today?

Are you aware of the concept of sea level rise?

Yes No

What do you believe are the causes of sea level rise, if any?

---

50 years from now, how many meters do you think the sea level will change as compared to today?

Here is the map of Wellington Central. This way is north. Here are the location of Te Papa, the Beehive, and Victoria University. We are here. Please shade in the area of the map that you think will be most impacted from sea level rise in 50 years?

This section we will be comparing sea level rise to earthquakes, tsunamis, and storm surges on a scale from 1-5, 1 being not at risk, 5 being at extreme risk. How at risk do you feel from: Earthquakes, Tsunamis, Storm surges, SLR?

	Not at risk		Somewhat at risk		At extreme risk
Earthquakes	1	2	3	4	5
Tsunamis	1	2	3	4	5
Storm Surges	1	2	3	4	5
Sea Level Rise	1	2	3	4	5

In the event of each of these natural disasters, how prepared do you feel for: earthquakes, tsunamis, storm surges, and sea level rise on a scale from 1-5; 1 being not prepared at all, 5 being very prepared?

	Not prepared		Somewhat prepared		Very prepared
Earthquakes	1	2	3	4	5
Tsunamis	1	2	3	4	5
Storm Surges	1	2	3	4	5
Sea Level Rise	1	2	3	4	5

Do you think it is necessary for some policy to be enacted to respond to sea level rise? If so how do you think the region has to enact the policy before it would become ineffective?

Yes_____ No

Please the list any community strategies you are aware of to respond to sea level rise, if any.

Which sources have helped to inform your knowledge about sea level rise?

Of those sources, which do you frequent most often?

Thank you so much for taking or survey. If you think of any further question you can email us at NZ-Climate@wpi.edu or call either 021-022-57676 or 210-664-414 to speak with one of our team members.

Appendix B: Convenience Survey and Map Iteration 2

Hello, would you be willing to participate in a 10 minute survey about sea level rise? We are a group of students from an American university called Worcester Polytechnic Institute. We are conducting a research project which will be published through our university. Our goal is to research the public understanding of sea level rise, in order to improve public communication of new environmental information. Therefore, we would like to know what you know about sea level rise in Wellington. Your participation is voluntary meaning you do not have to participate and you can skip any question you feel uncomfortable answering. We will only be using personal information to understand the demographic distribution, we will not be publishing any identifiable information. Do you have any questions about this survey?

What is your gender identity?

Male Female Other

What is your age?

16-19 20-29 30-39 40-49 50-59 60-69 70+

What is your ethnic background?

European Maori Pacific People Asian Other_____

What is your relationship status?

Single In a Partnership Other

Do you have children?

Yes No

What is your highest level of education?

Do you live in the Wellington city? If so, what suburb?

Why are you visiting the Central Business District today? What do you do?

How aware are you of the concept of sea level rise on a scale from 1 to 5, 1 being not aware, 5 being very aware?

1 2 3 4 5

What do you believe are the causes of sea level rise, if any?

Do you think that sea level rise will impact you in you in your lifetime?_____

50 years from now, how many meters do you think the sea level will change as compared to today?

Here is the map of Wellington Central. This way is north. Here are the location of Te Papa, the Beehive, and Victoria University. We are here. Please shade in the area of the map that you think will be most impacted from sea level rise in 50 years?

This section we will be comparing sea level rise to earthquakes, tsunamis, and storm surges on a scale from 1-5, 1 being not at risk, 5 being at extreme risk. How at risk do you feel from: Earthquakes, Tsunamis, Storm surges, SLR?

	Not at risk		Somewhat at risk		At extreme risk
Earthquakes	1	2	3	4	5
Tsunamis	1	2	3	4	5
Storm Surges	1	2	3	4	5
Sea Level Rise	1	2	3	4	5

In the event of each of these natural disasters, how prepared do you feel for: earthquakes, tsunamis, storm surges, and sea level rise on a scale from 1-5; 1 being not prepared at all, 5 being very prepared?

	Not prepared		Somewhat prepared		Very prepared
Earthquakes	1	2	3	4	5
Tsunamis	1	2	3	4	5
Storm Surges	1	2	3	4	5
Sea Level Rise	1	2	3	4	5

Do you think it is necessary for some policy to be enacted to respond to sea level rise? If so how do you think the region has to enact the policy before it would become ineffective?

Yes_____ No

Which sources have helped to inform your knowledge about sea level rise?

_____

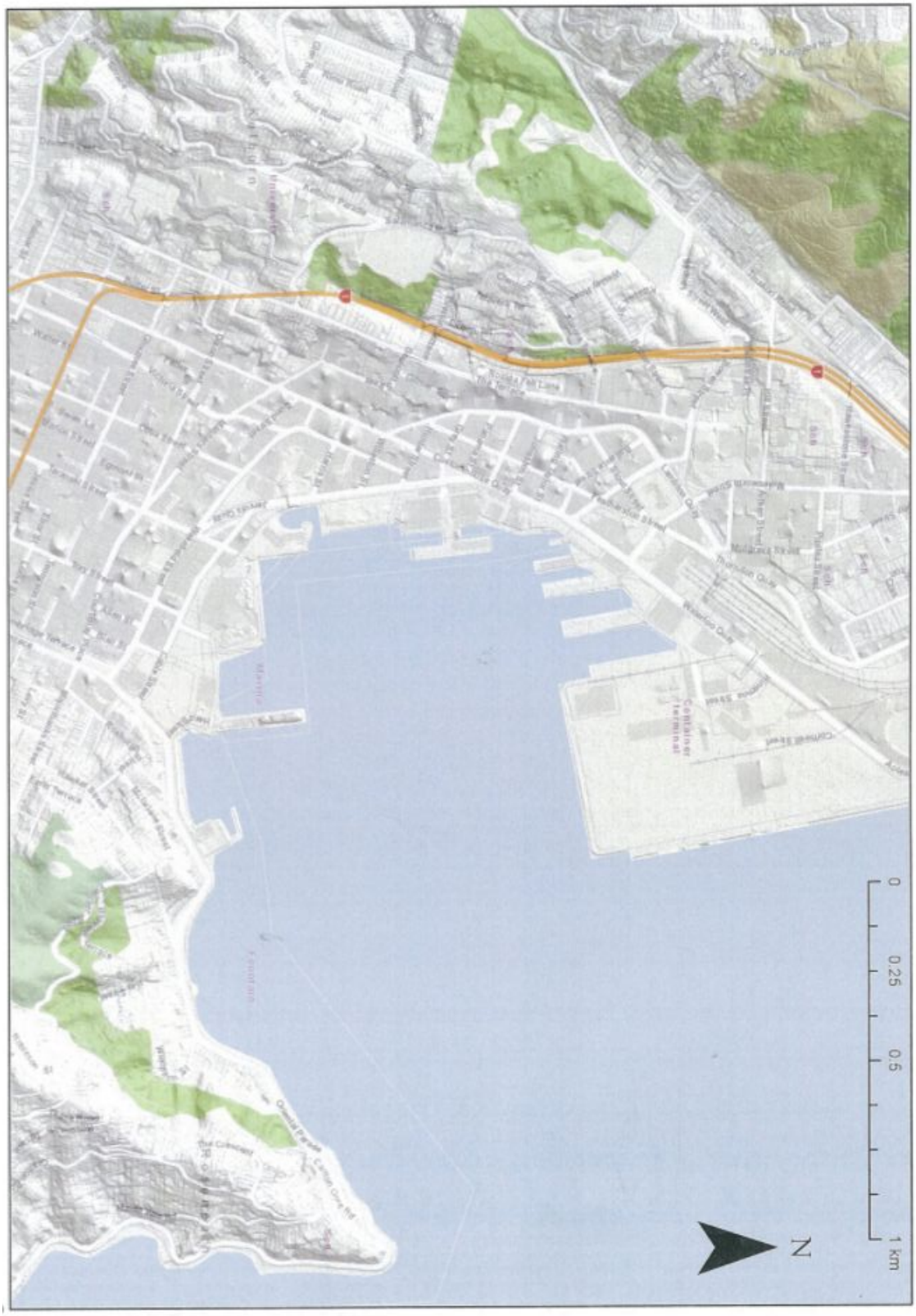
_____

Are you aware of any recent publications from the GWRC or other organizations relating to sea level rise?

_____

_____

Thank you so much for taking or survey. If you think of any further question you can email us at NZ-Climate@wpi.edu or call either 021-022-57676 or 210-664-414 to speak with one of our team members.


0
0.25
0.5
1 km
N

Appendix C: Interview Outline

How did you get into the field you are currently working in? (What is your background?)

What have your experiences been in communicating science research to [the public, local officials]?

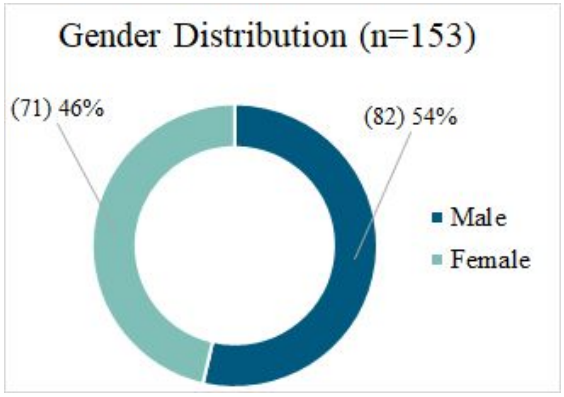
What were some successes you have experienced in climate science communication? Failures?

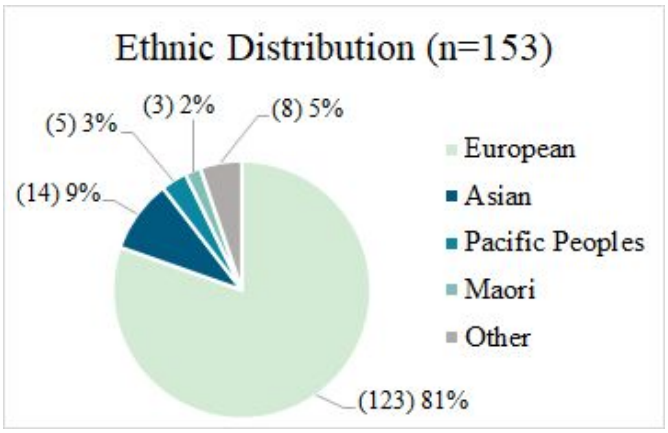
In your opinion is the [public, local officials] well-informed about SLR?

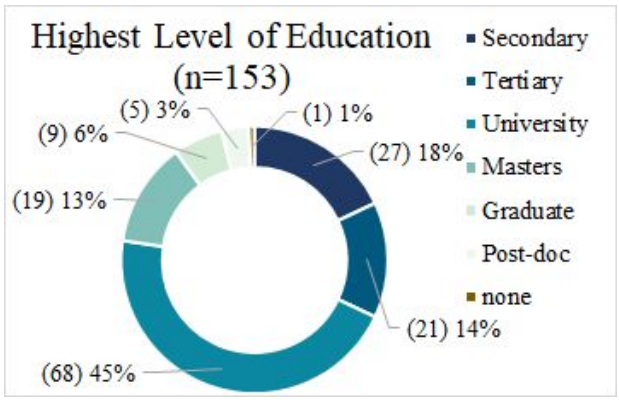
Have you noticed any pressure from the public for or against SLR policy?

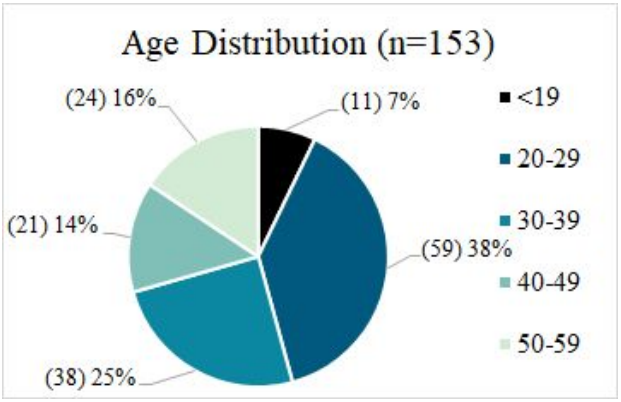
Is there anything else you would like to share with us that you think would be helpful for our research?

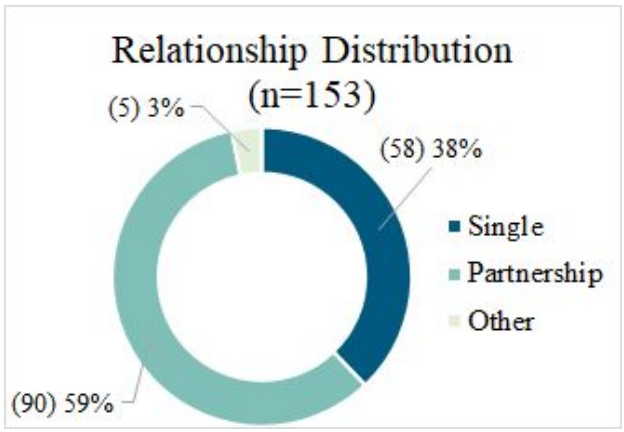
Appendix D: Demographic Data

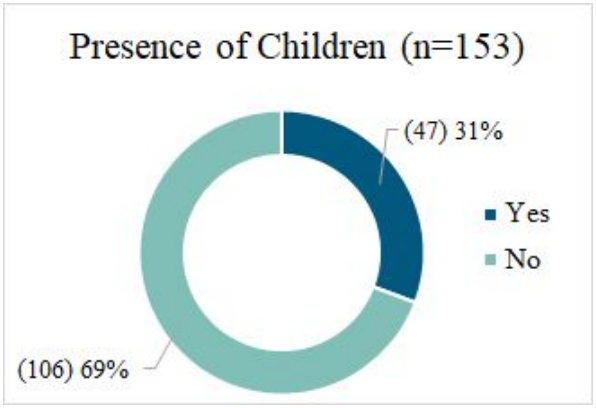


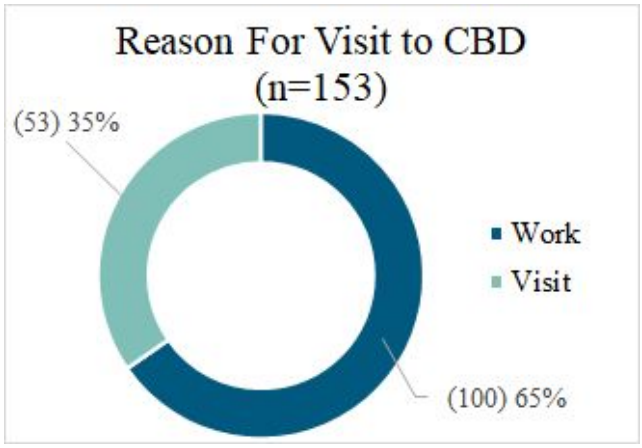


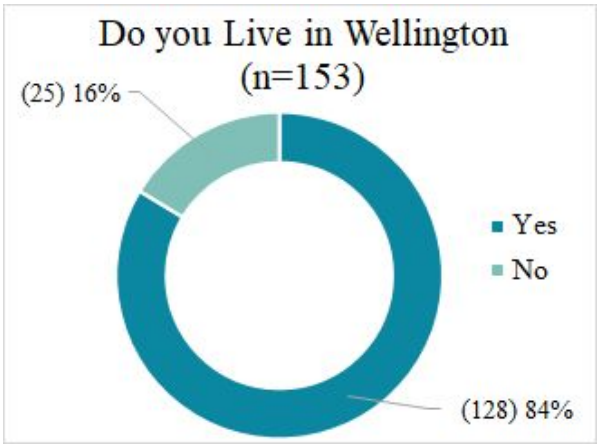


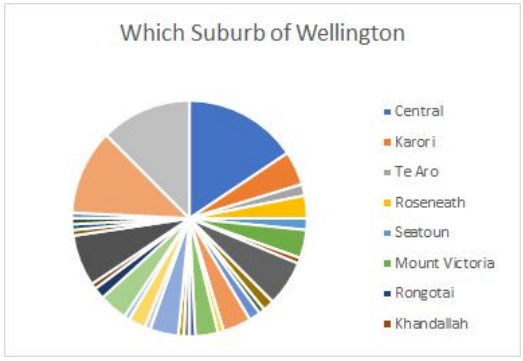


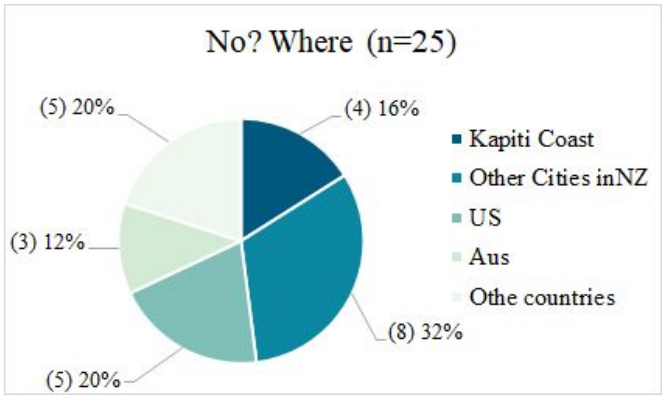





Reason For Visit to CBD
(n=153)
(53) 35%
(100) 65%
Work
Visit

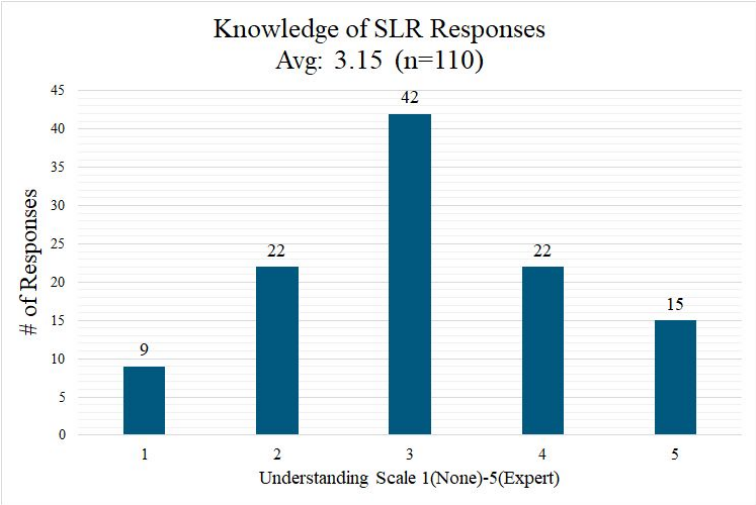

Do you Live in Wellington
(n=153)
(25) 16%
(128) 84%
Yes
No

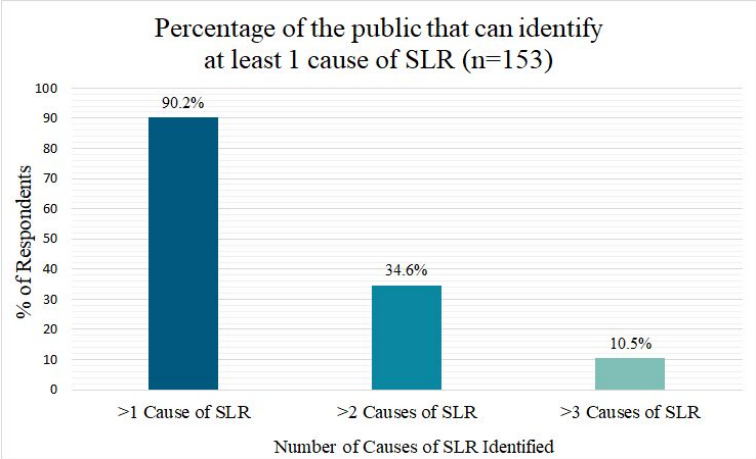

Which Suburb of Wellington
Central
Karori
Te Aro
Roseneath
Seatoun
Mount Victoria
Rongotai
Khandallah

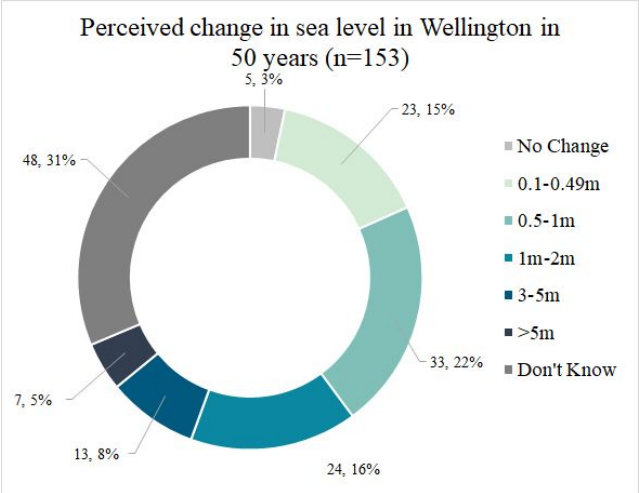

No? Where (n=25)
(5) 20%
(4) 16%
(3) 12%
(8) 32%
(5) 20%
Kapiti Coast
Other Cities inNZ
US
Aus
Othe countries

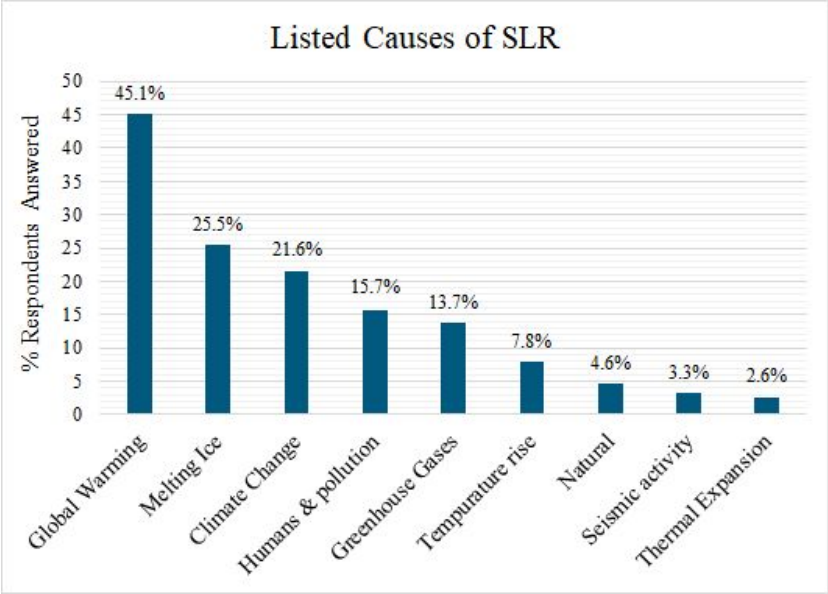
Appendix E: Graphical Representation of Data from Convenience Surveys

Knowledge of SLR

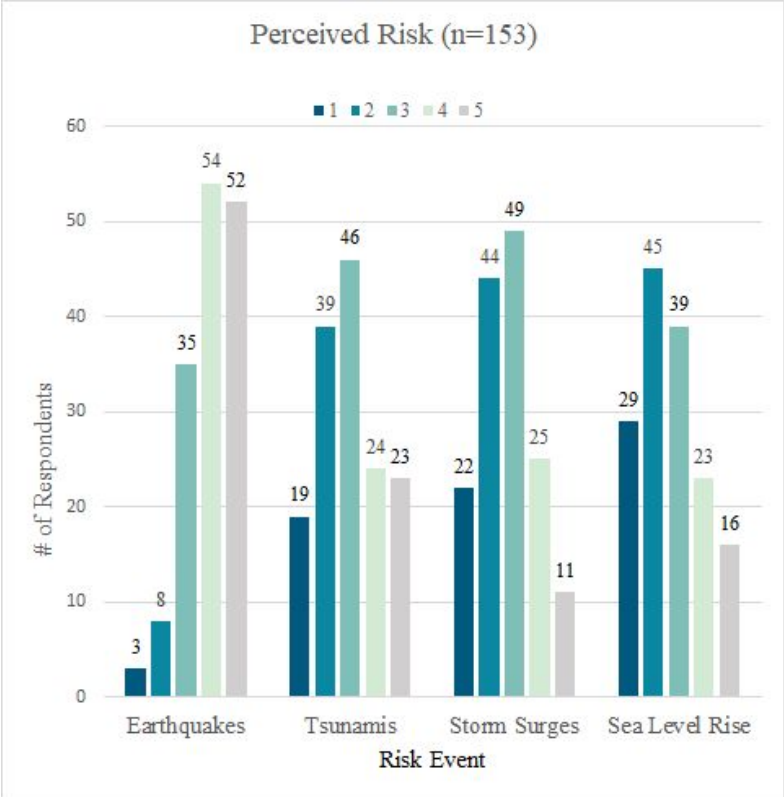


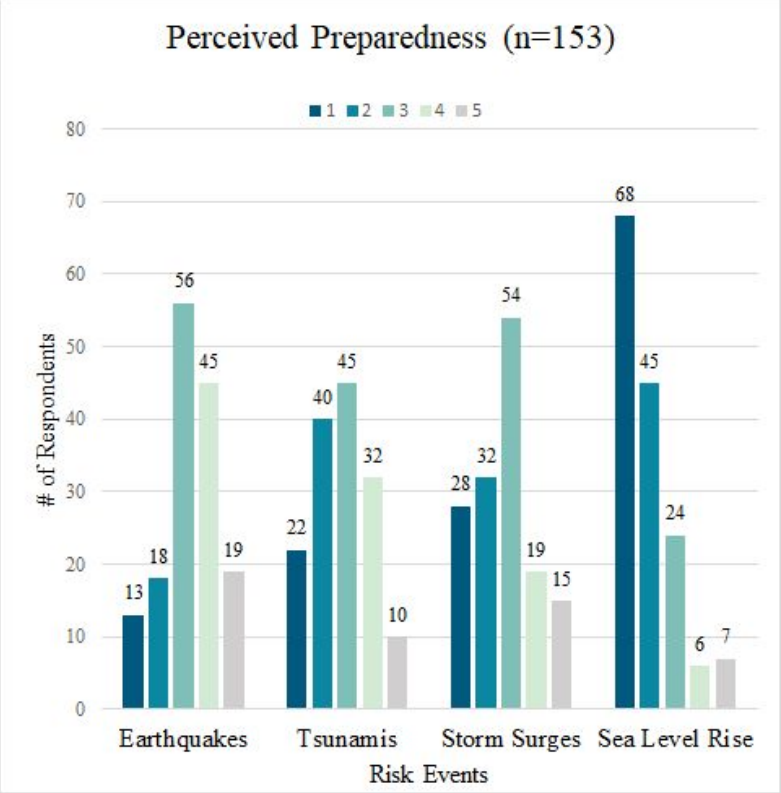


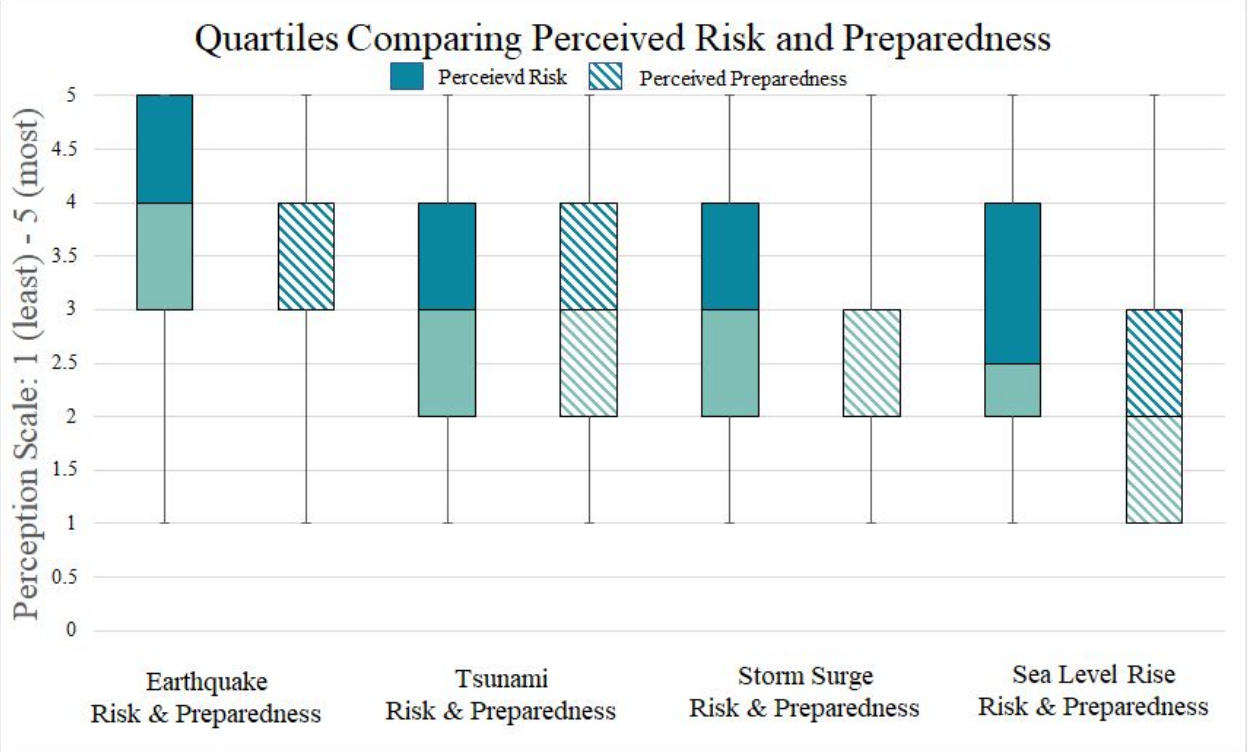


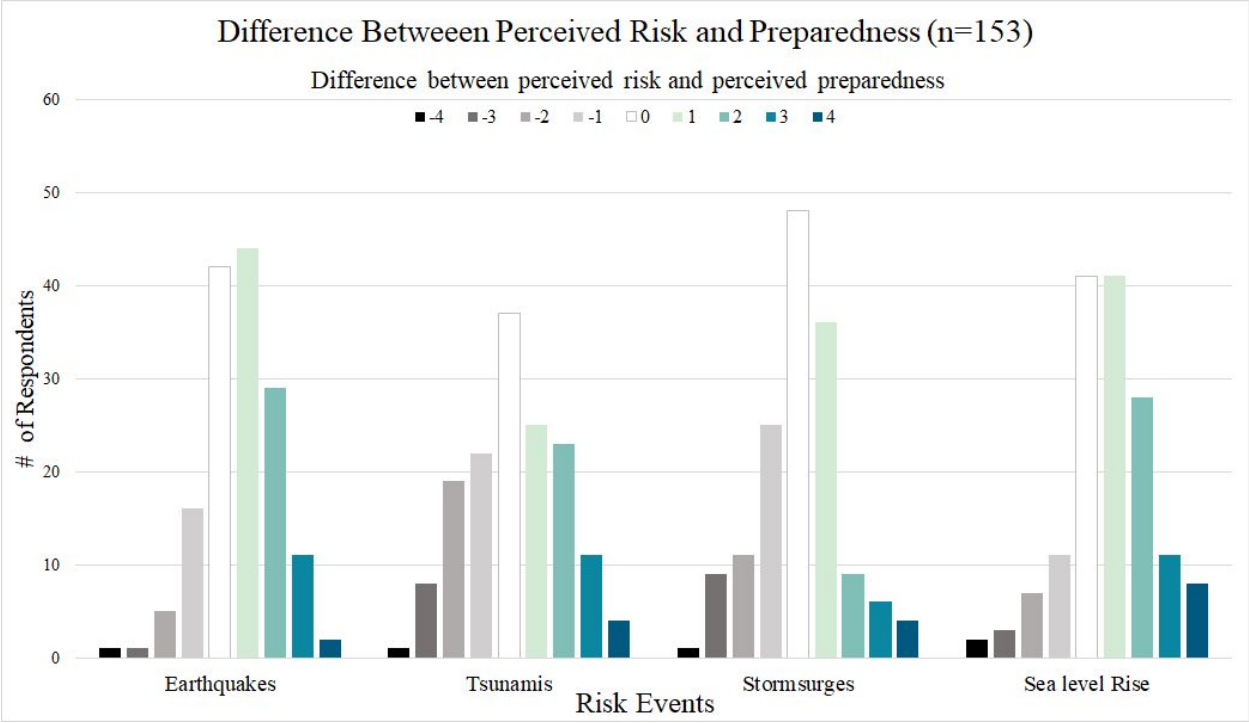


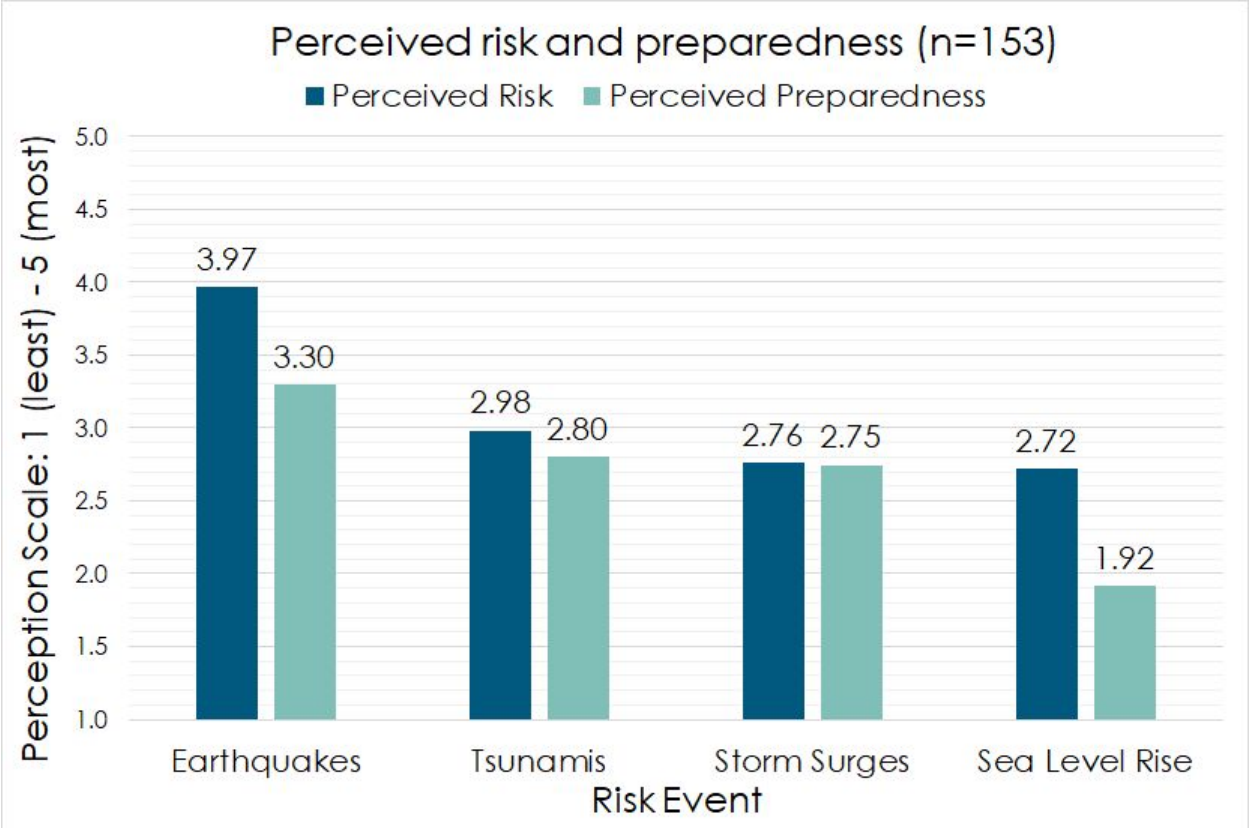
Perceived Risk and Preparedness



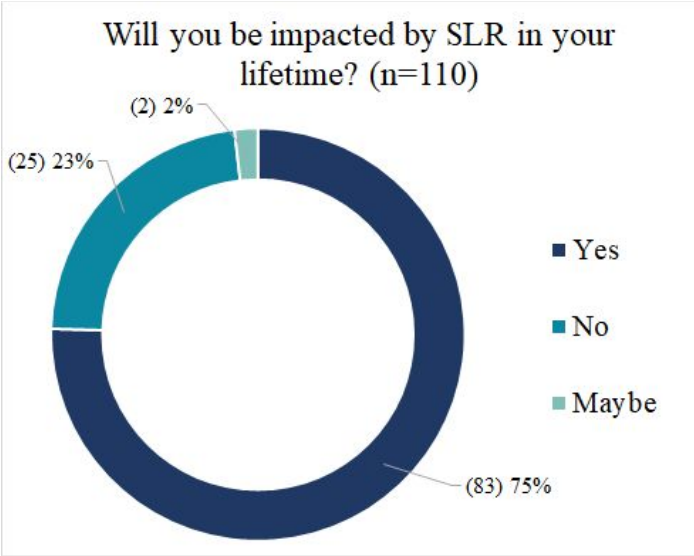

Perceived Preparedness (n=153)
1 2 3 4 5
# of Respondents
80
70
60
50
40
30
20
10
0
13 18 56 45 19
22 40 45 32 10
28 32 54 19 15
68 45 24 6 7
Earthquakes
Tsunamis
Storm Surges
Sea Level Rise
Risk Events

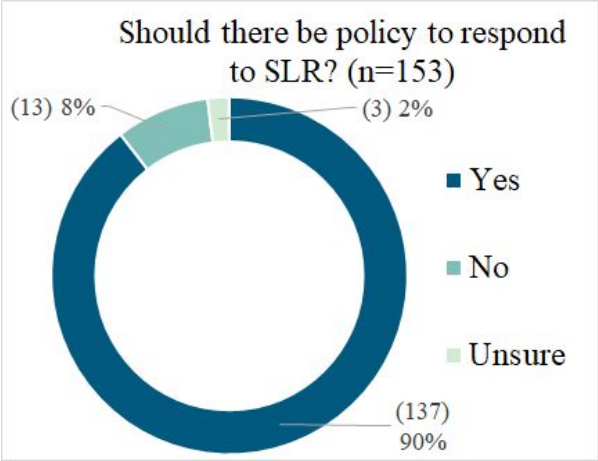

Quartiles Comparing Perceived Risk and Preparedness
Perceievd Risk
Perceived Preparedness
Perception Scale: 1 (least) - 5 (most)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Earthquake Risk & Preparedness
Tsunami Risk & Preparedness
Storm Surge Risk & Preparedness
Sea Level Rise Risk & Preparedness

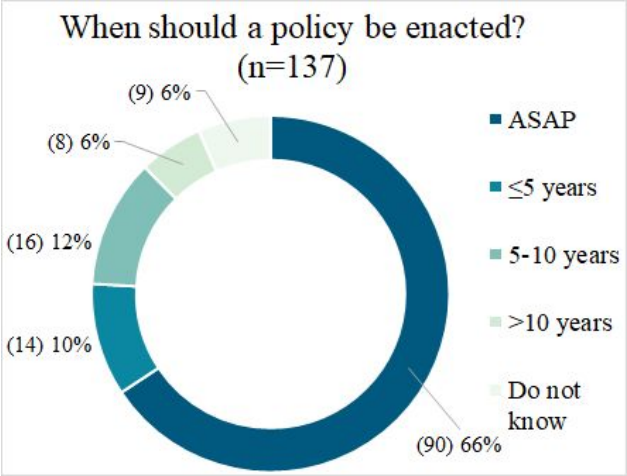

Difference Betweeen Perceived Risk and Preparedness (n=153)
Difference between perceived risk and perceived preparedness
-4 -3 -2 -1 0 1 2 3 4
60
50
40
30
20
10
0
# of Respondents
Earthquakes
Tsunamis
Stormsurges
Sea level Rise
Risk Events


Perceived risk and preparedness (n=153)
Perceived Risk
Perceived Preparedness
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Perception Scale: 1 (least) - 5 (most)
3.97
3.30
2.98
2.80
2.76
2.75
2.72
1.92
Earthquakes
Tsunamis
Storm Surges
Sea Level Rise
Risk Event

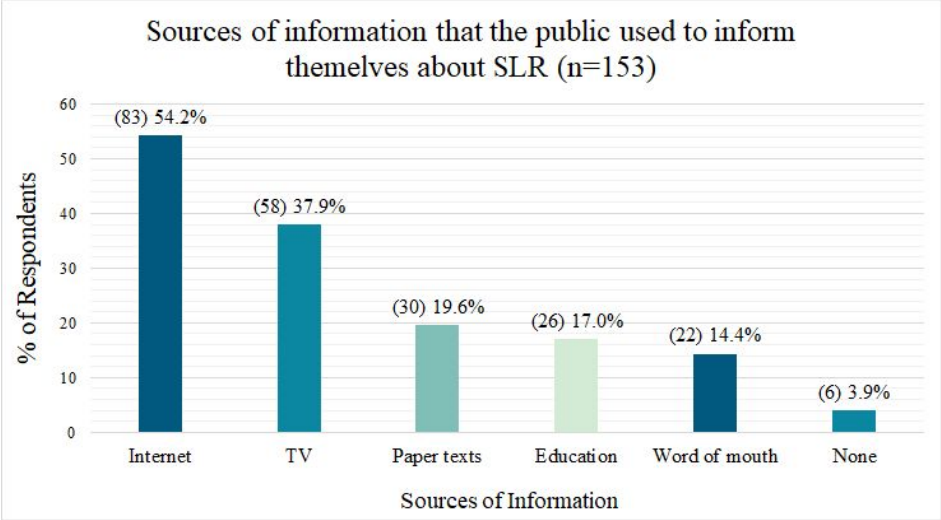
Impacts of SLR



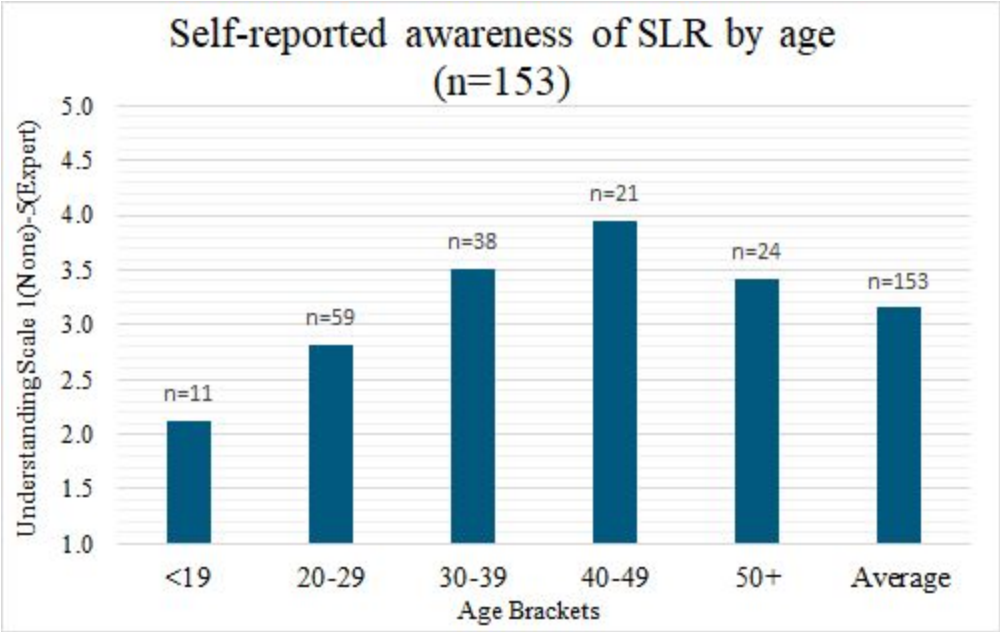


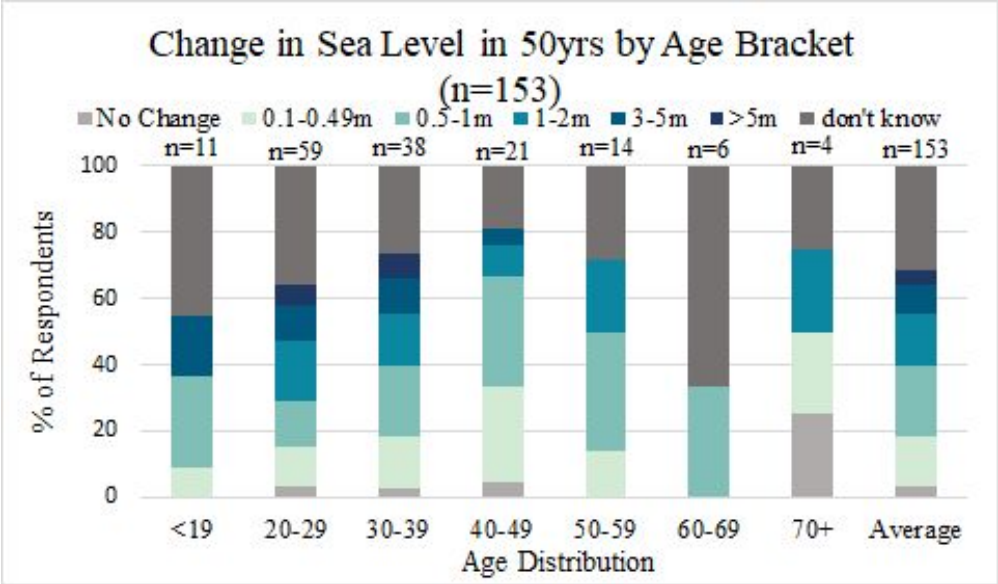


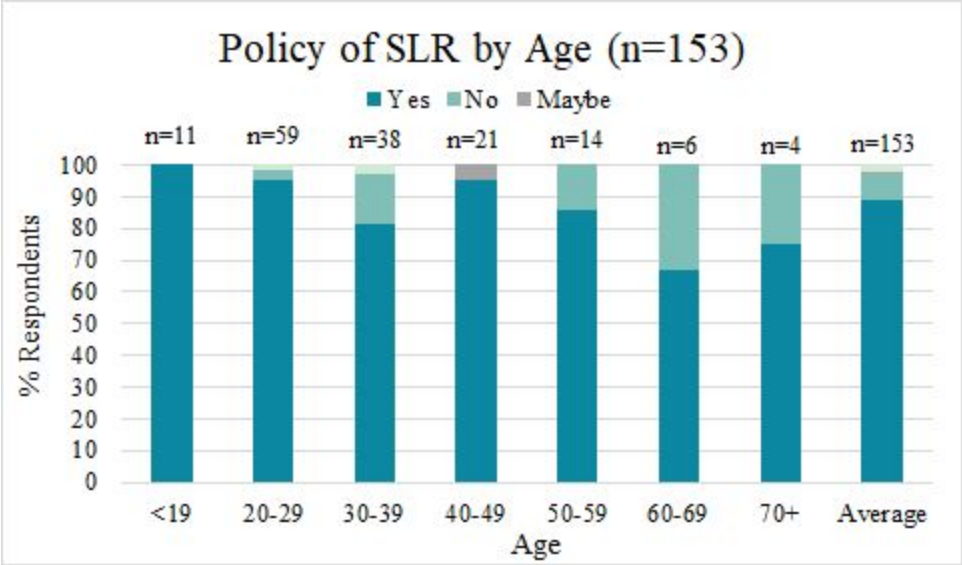
Sources of Information

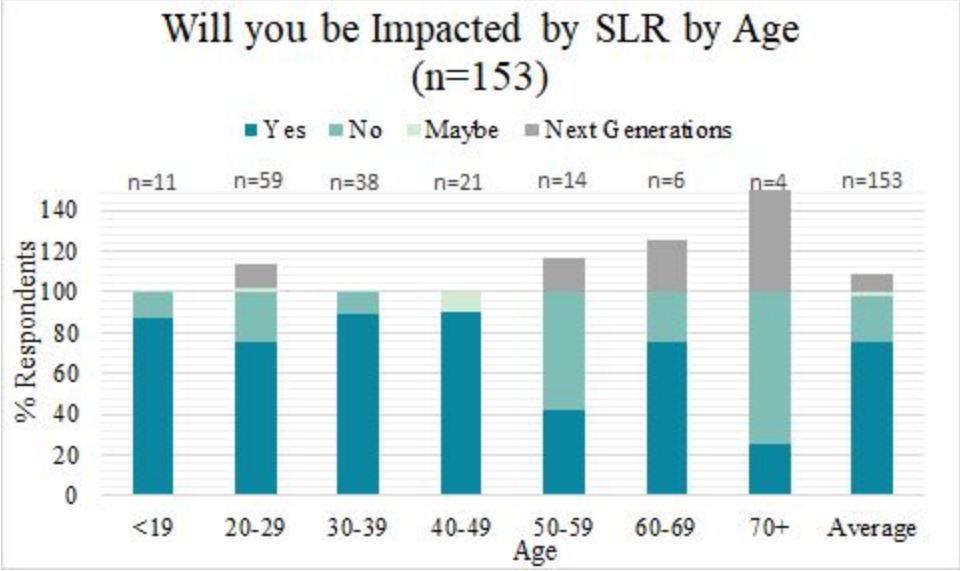


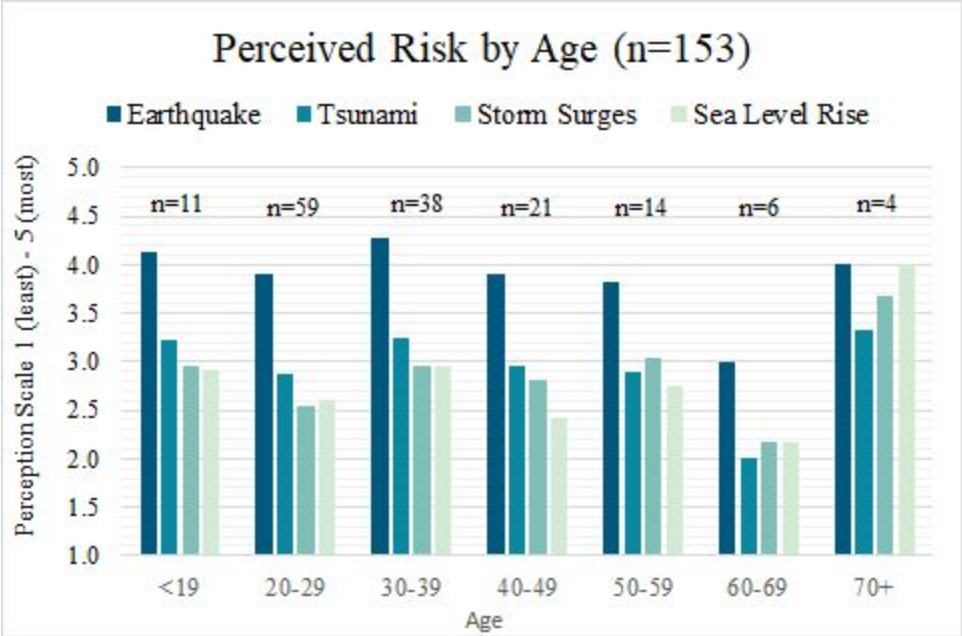
Appendix F: Cross-Tabulation: Age and SLR Data

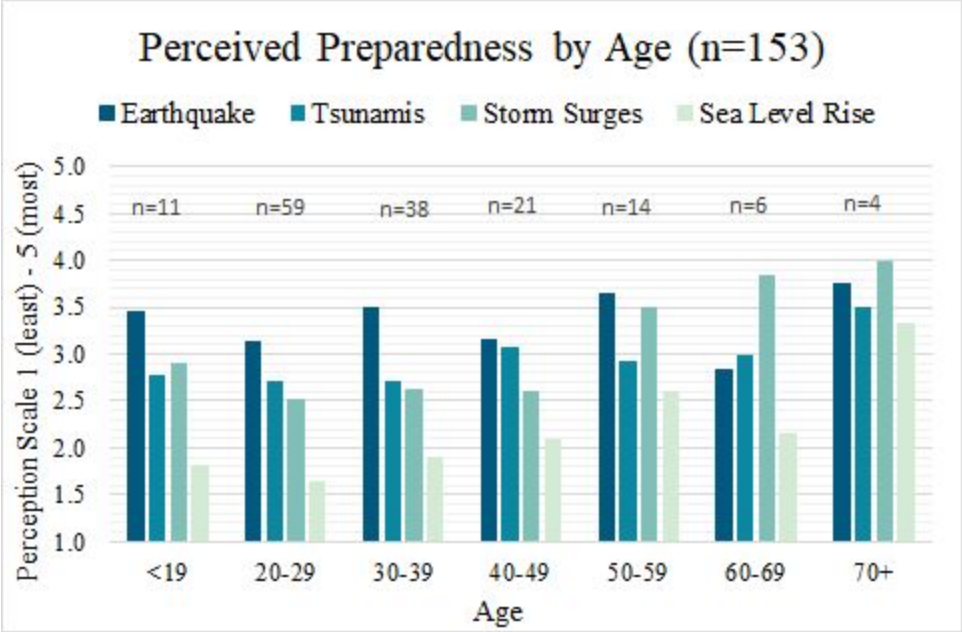




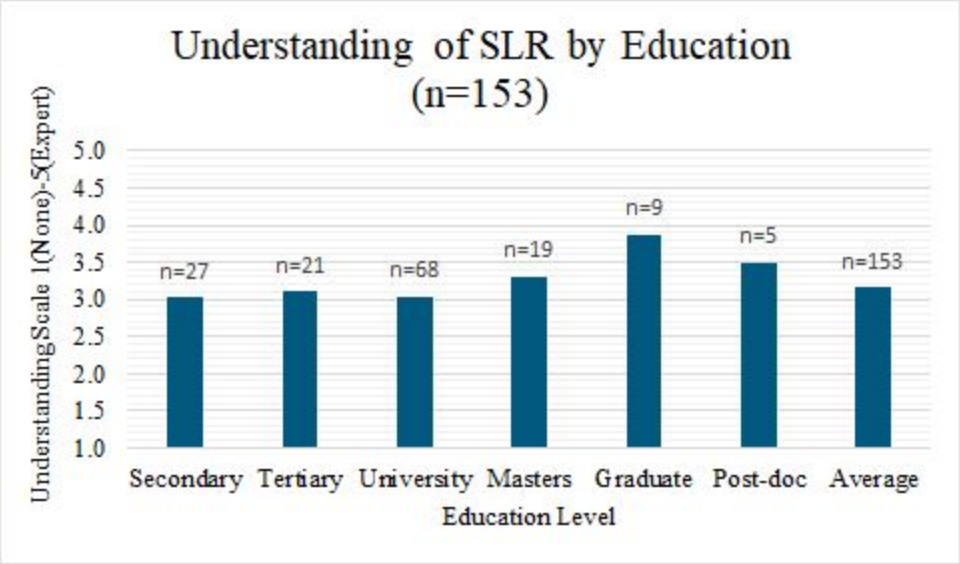

Policy of SLR by Age (n=153)
Yes
No
Maybe
n=11
n=59
n=38
n=21
n=14
n=6
n=4
n=153
100
90
80
70
60
50
40
30
20
10
0
% Respondents
<19
20-29
30-39
40-49
50-59
60-69
70+
Average
Age

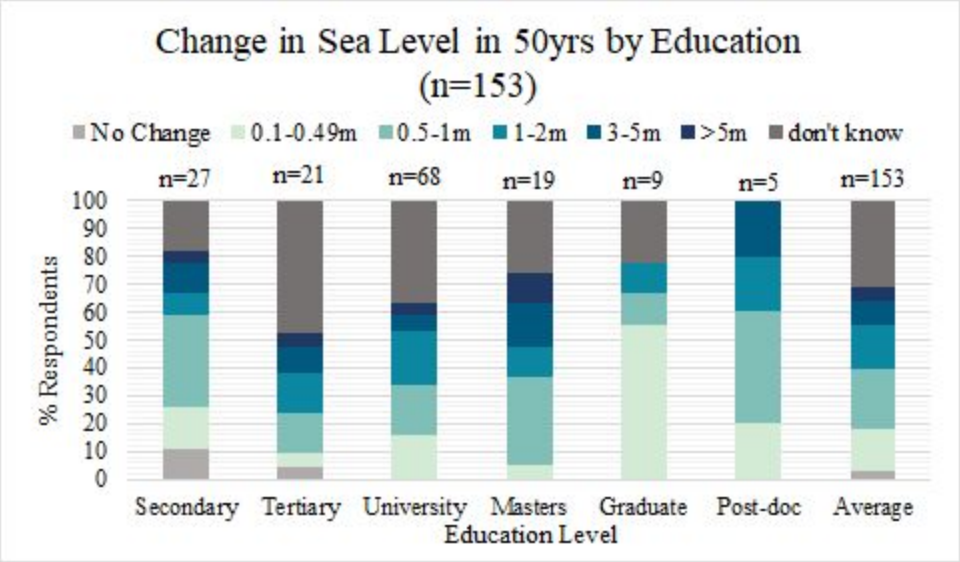

Will you be Impacted by SLR by Age (n=153)
Yes
No
Maybe
Next Generations
n=11
n=59
n=38
n=21
n=14
n=6
n=4
n=153
140
120
100
80
60
40
20
0
% Respondents
<19
20-29
30-39
40-49
50-59
60-69
70+
Average
Age

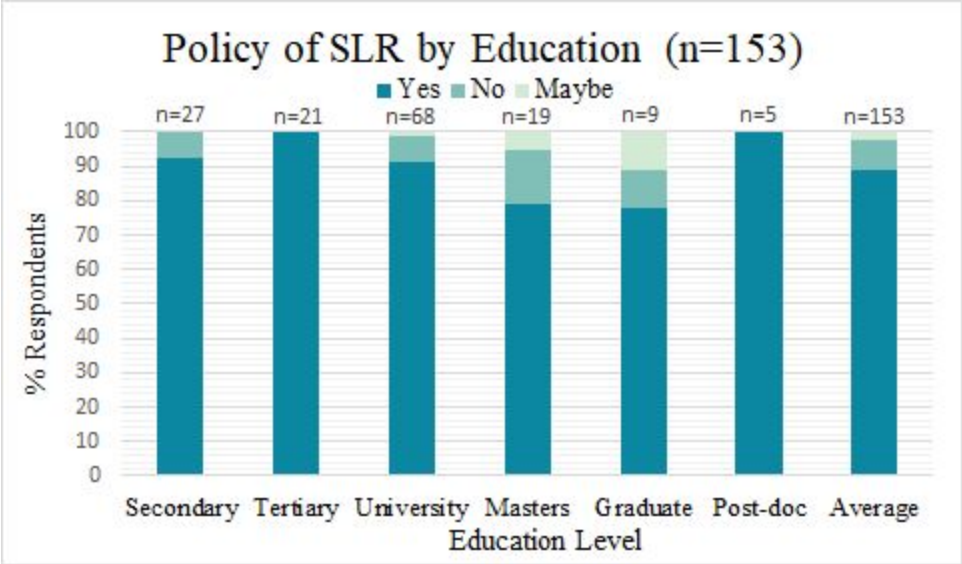

Perceived Risk by Age (n=153)
Earthquake
Tsunami
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
n=11
n=59
n=38
n=21
n=14
n=6
n=4
<19
20-29
30-39
40-49
50-59
60-69
70+
Age

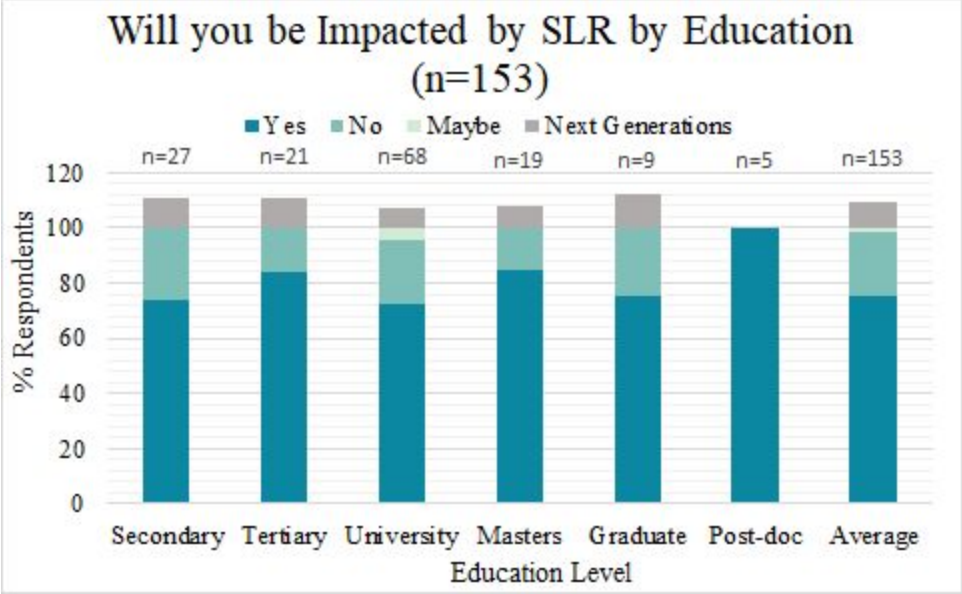

Perceived Preparedness by Age (n=153)
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
n=11
n=59
n=38
n=21
n=14
n=6
n=4
<19
20-29
30-39
40-49
50-59
60-69
70+
Age

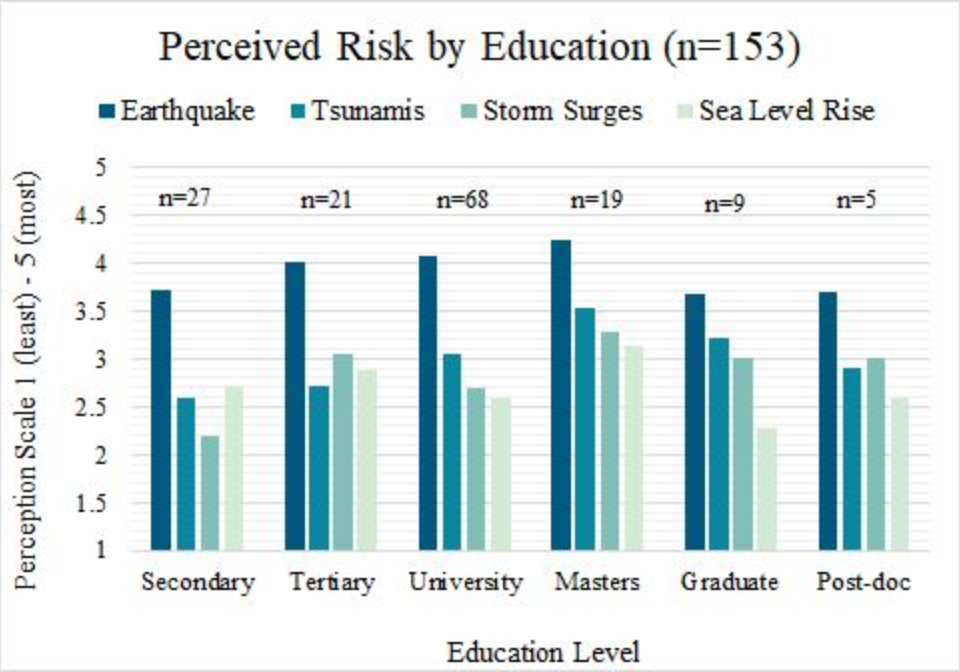
Appendix G: Cross-tabulation: Education and SLR Data

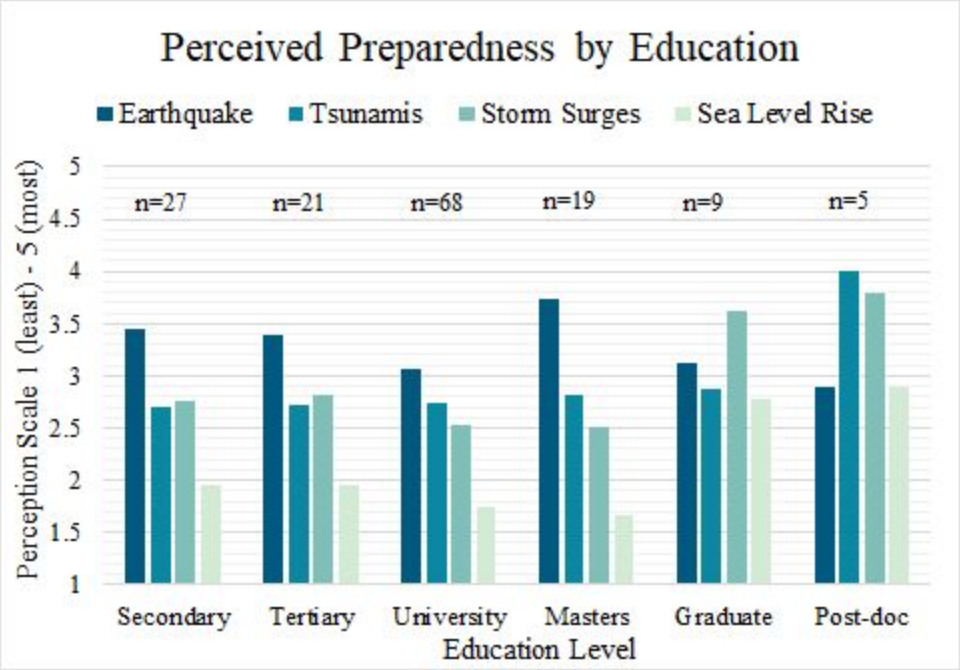




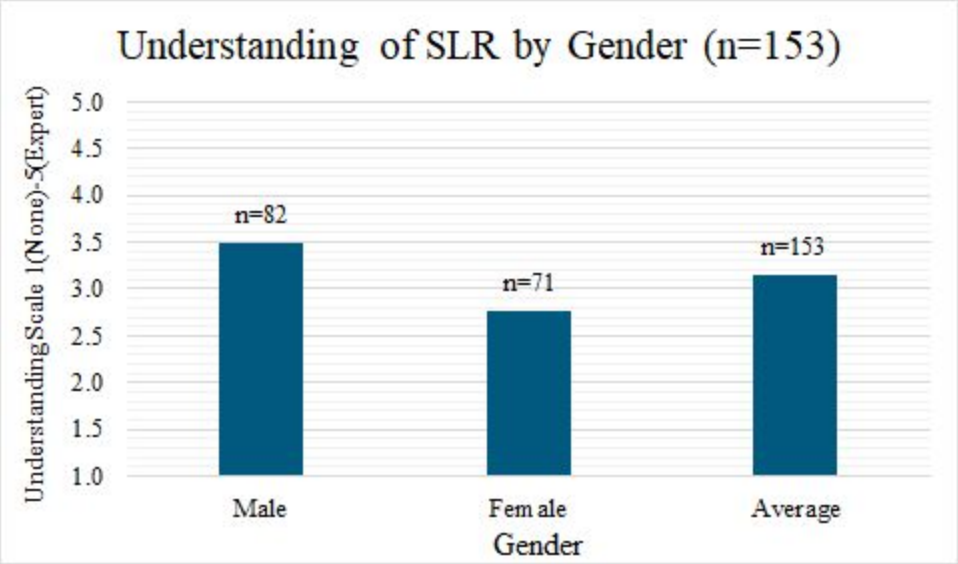

Policy of SLR by Education (n=153)
Yes
No
Maybe
n=27
n=21
n=68
n=19
n=9
n=5
n=153
100
90
80
70
60
50
40
30
20
10
0
% Respondents
Secondary
Tertiary
University
Masters
Graduate
Post-doc
Average
Education Level

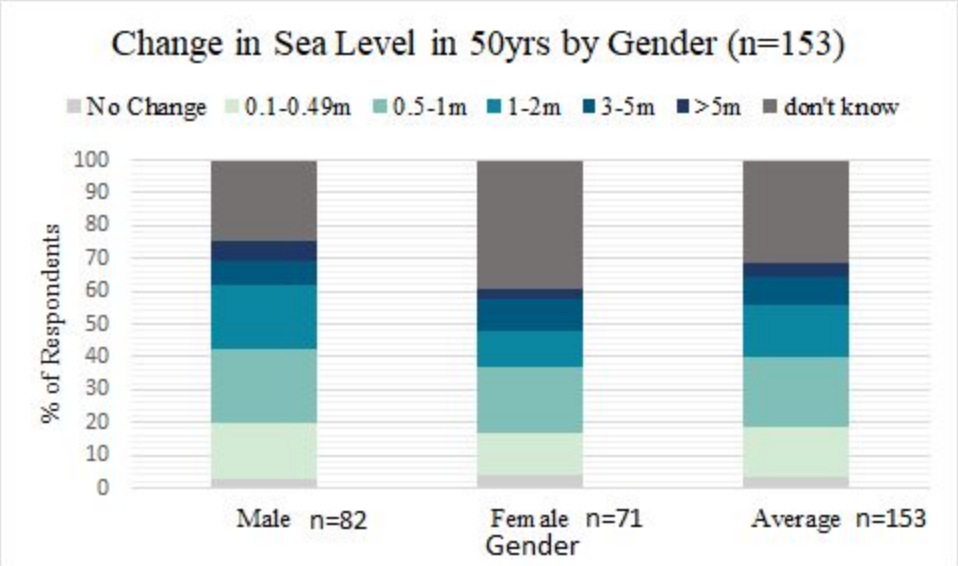

Will you be Impacted by SLR by Education (n=153)
Yes
No
Maybe
Next Generations
n=27
n=21
n=68
n=19
n=9
n=5
n=153
120
100
80
60
40
20
0
% Respondents
Secondary
Tertiary
University
Masters
Graduate
Post-doc
Average
Education Level

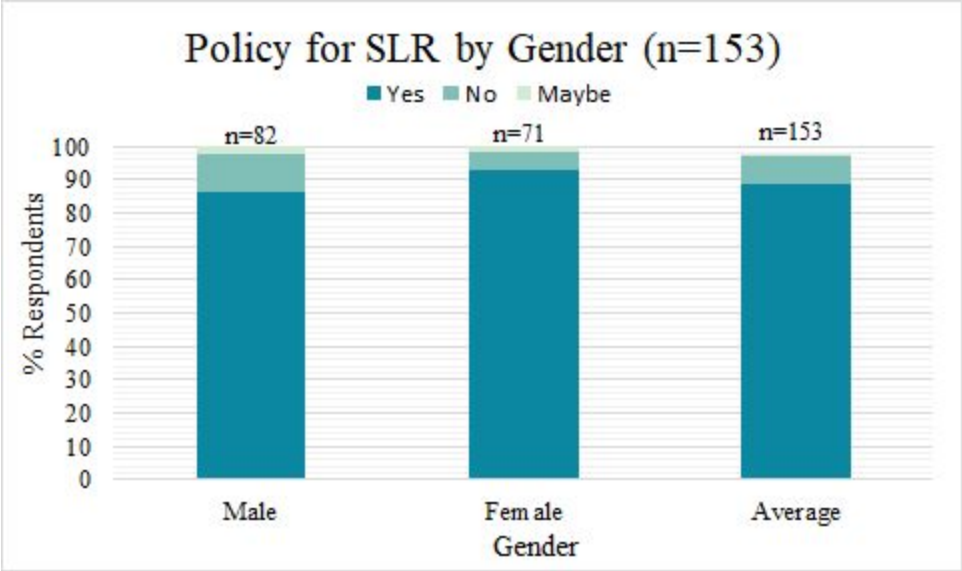

Perceived Risk by Education (n=153)
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5
4.5
4
3.5
3
2.5
2
1.5
1
n=27
n=21
n=68
n=19
n=9
n=5
Secondary
Tertiary
University
Masters
Graduate
Post-doc
Education Level

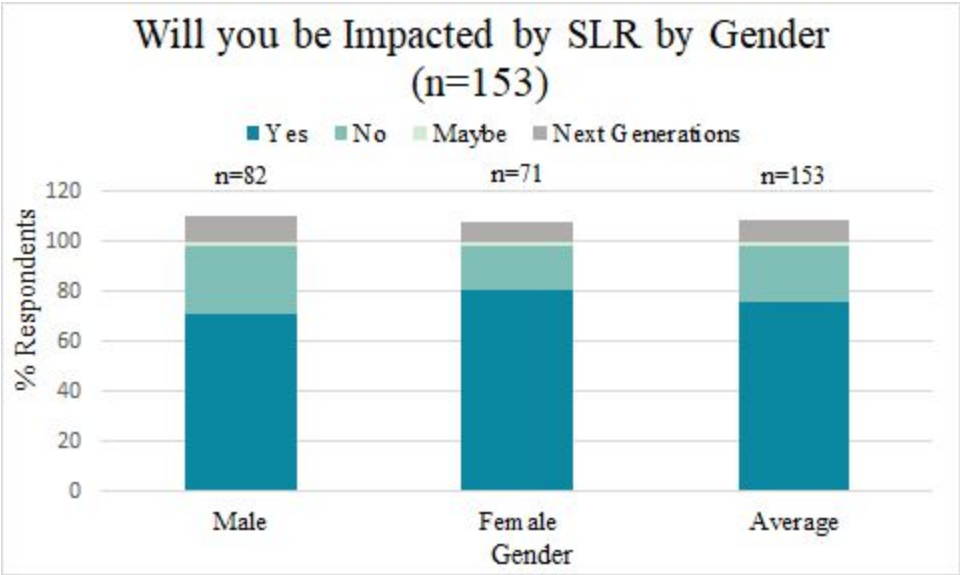

Perceived Preparedness by Education
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5
4.5
4
3.5
3
2.5
2
1.5
1
n=27
n=21
n=68
n=19
n=9
n=5
Secondary
Tertiary
University
Masters
Graduate
Post-doc
Education Level

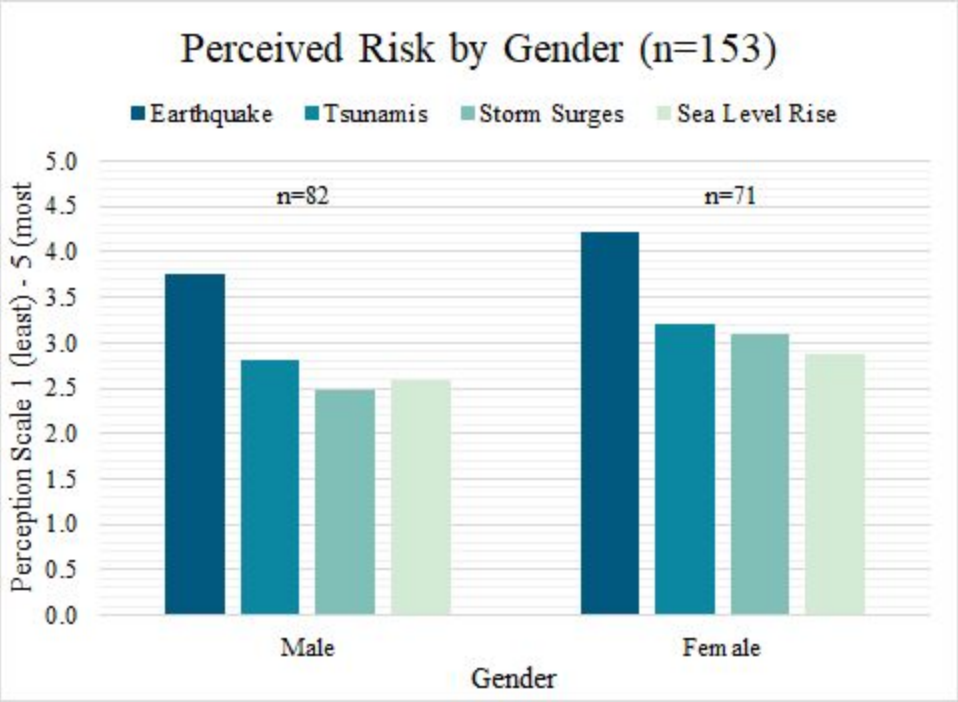
Appendix H: Cross-tabulation: Gender and SLR Data

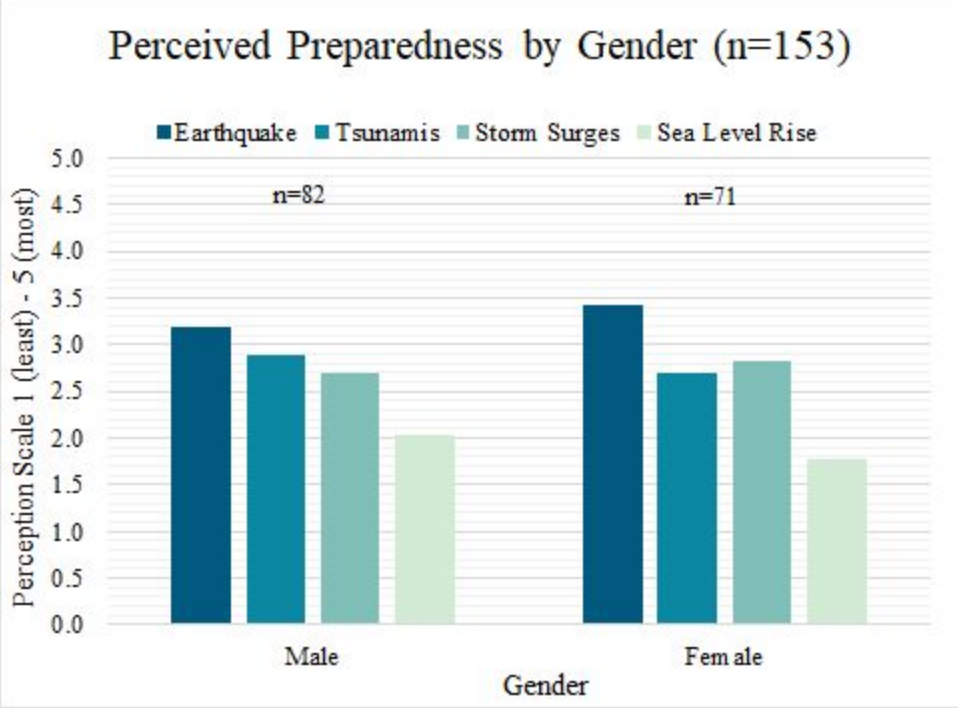




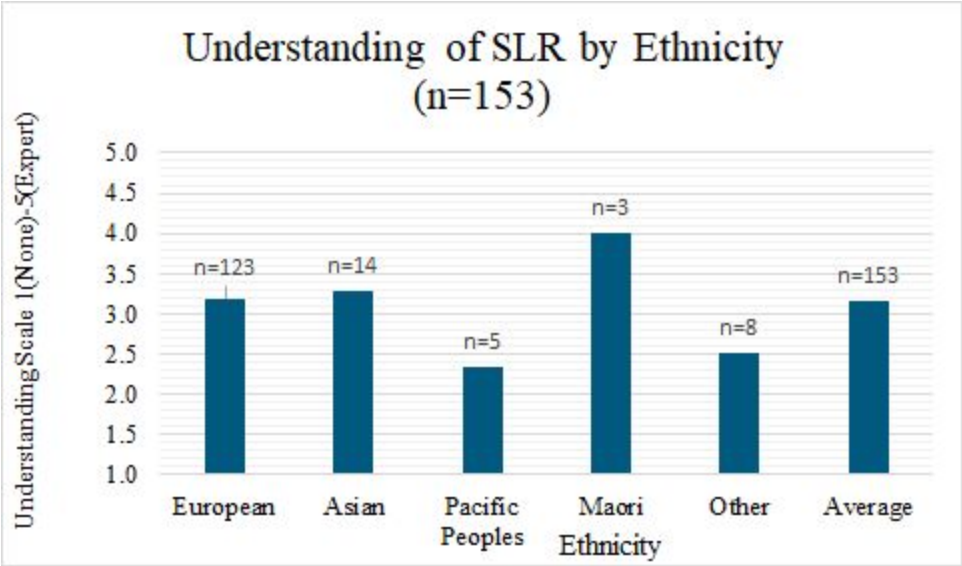

Policy for SLR by Gender (n=153)
Yes
No
Maybe
n=82
n=71
n=153
100
90
80
70
60
50
40
30
20
10
0
% Respondents
Male
Female
Average
Gender

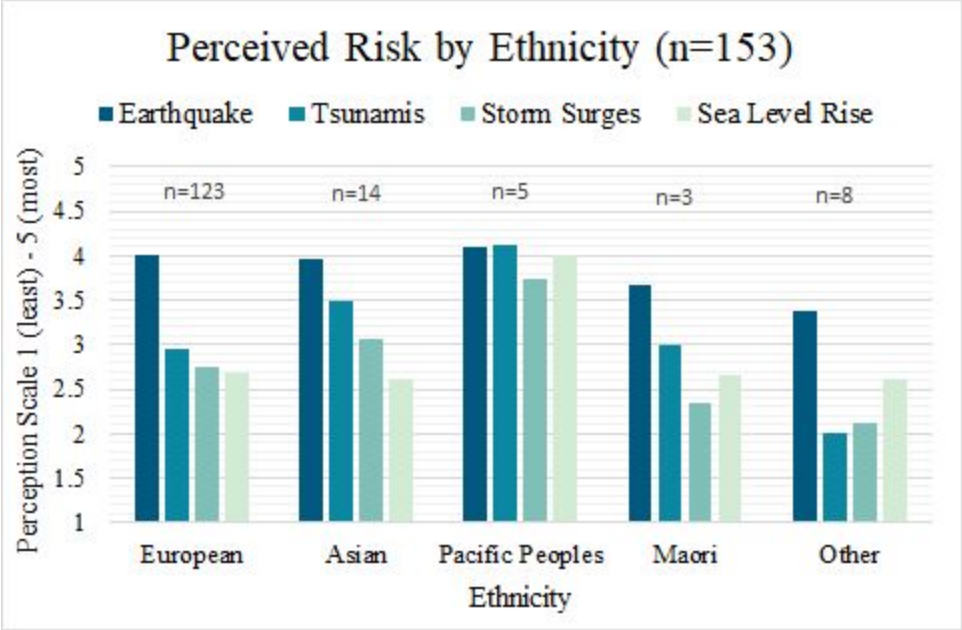

Will you be Impacted by SLR by Gender (n=153)
Yes
No
Maybe
Next Generations
n=82
n=71
n=153
120
100
80
60
40
20
0
% Respondents
Male
Female
Average
Gender

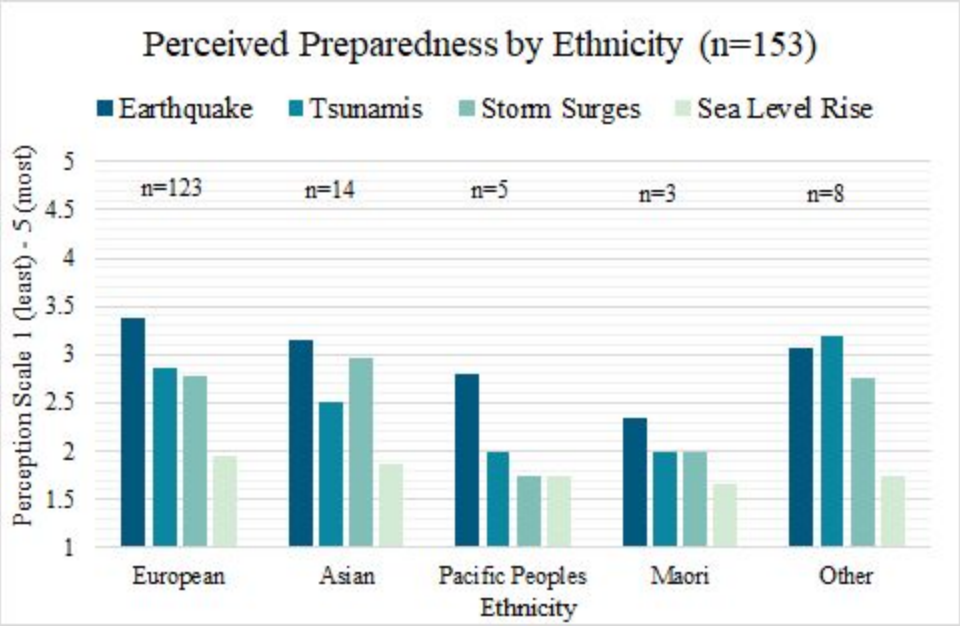

Perceived Risk by Gender (n=153)
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
n=82
n=71
Perception Scale 1 (least) - 5 (most
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Male
Female
Gender


Perceived Preparedness by Gender (n=153)
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
n=82
n=71
Perception Scale 1 (least) - 5 (most)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Male
Female
Gender

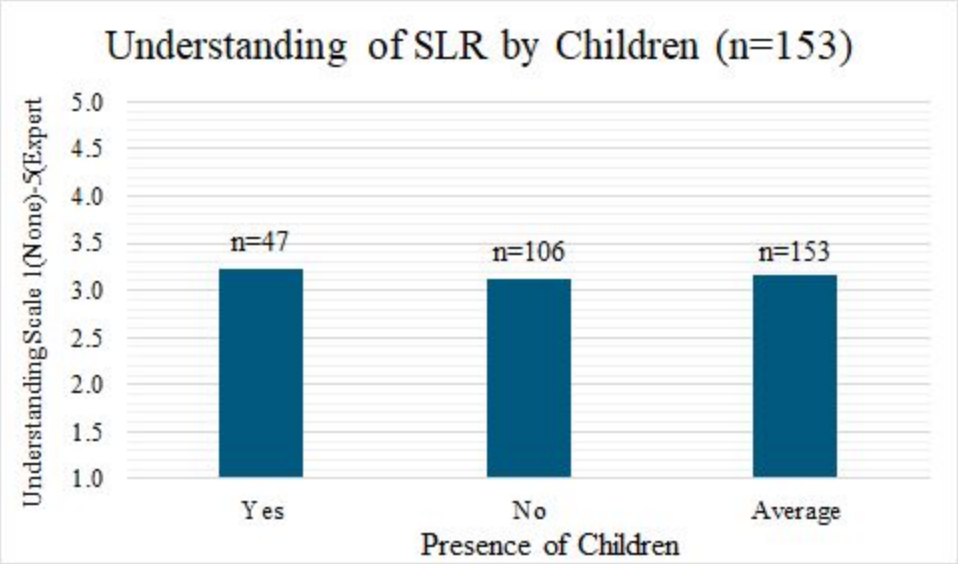
Appendix I: Cross-tabulation: Ethnicity and SLR Data

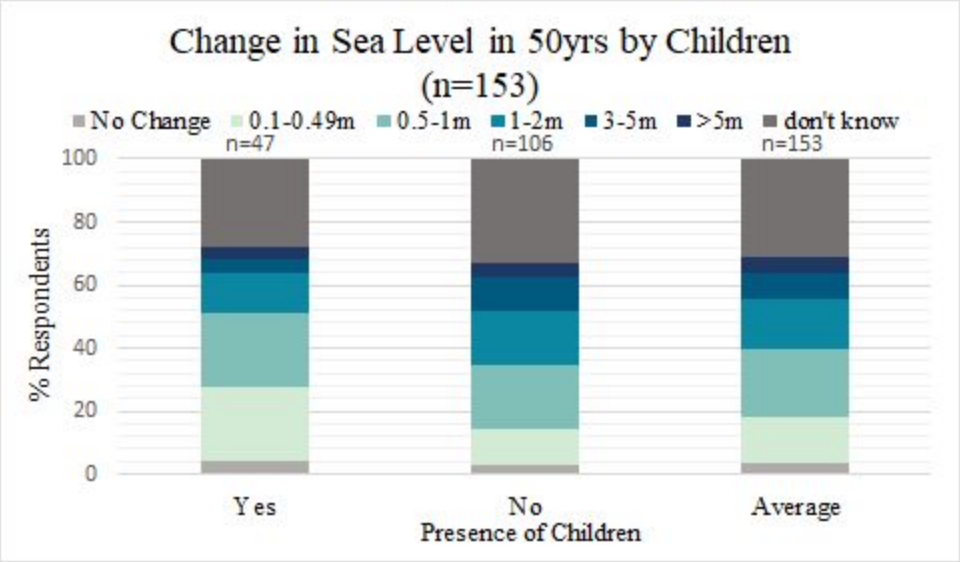


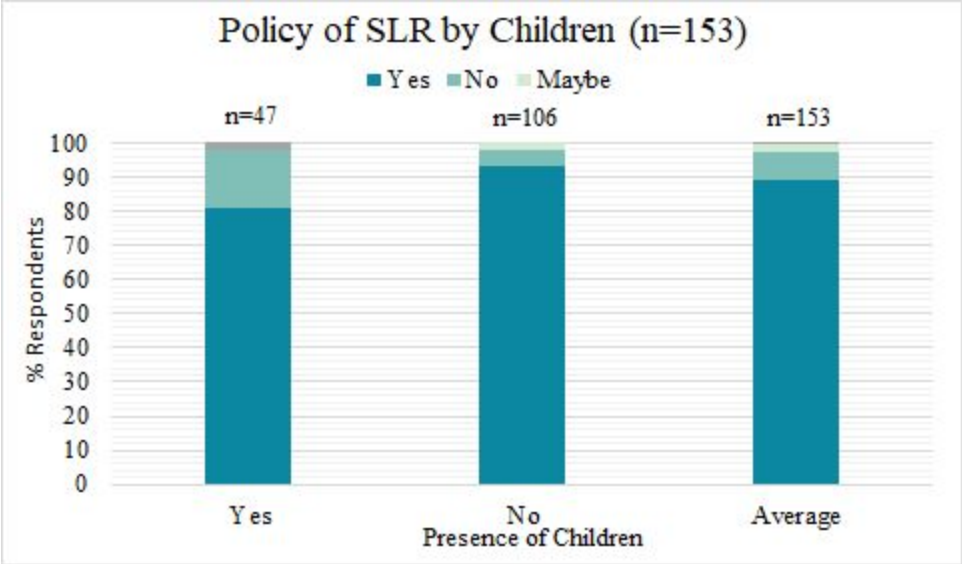


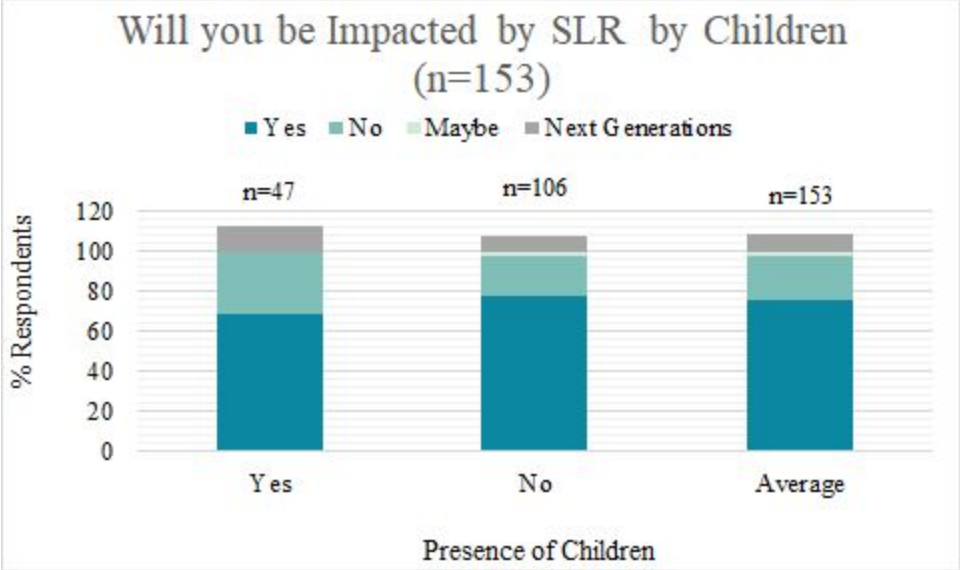

Perceived Preparedness by Ethnicity (n=153)
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5
4.5
4
3.5
3
2.5
2
1.5
1
n=123
n=14
n=5
n=3
n=8
European
Asian
Pacific Peoples
Maori
Other
Ethnicity

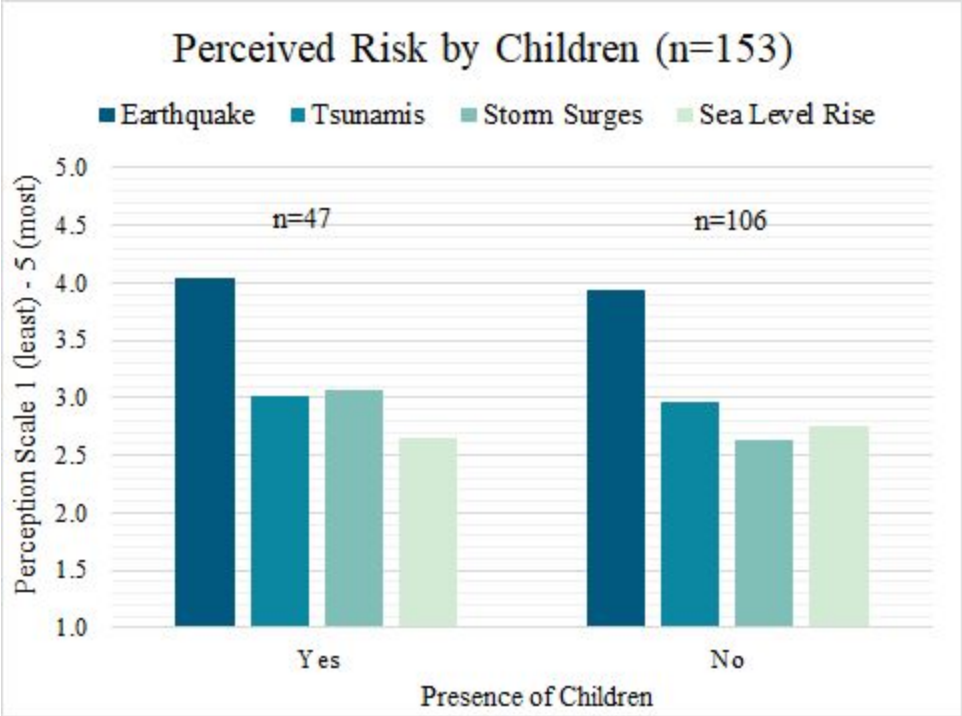
Appendix J: Cross-tabulation: Presence of Children and SLR Data

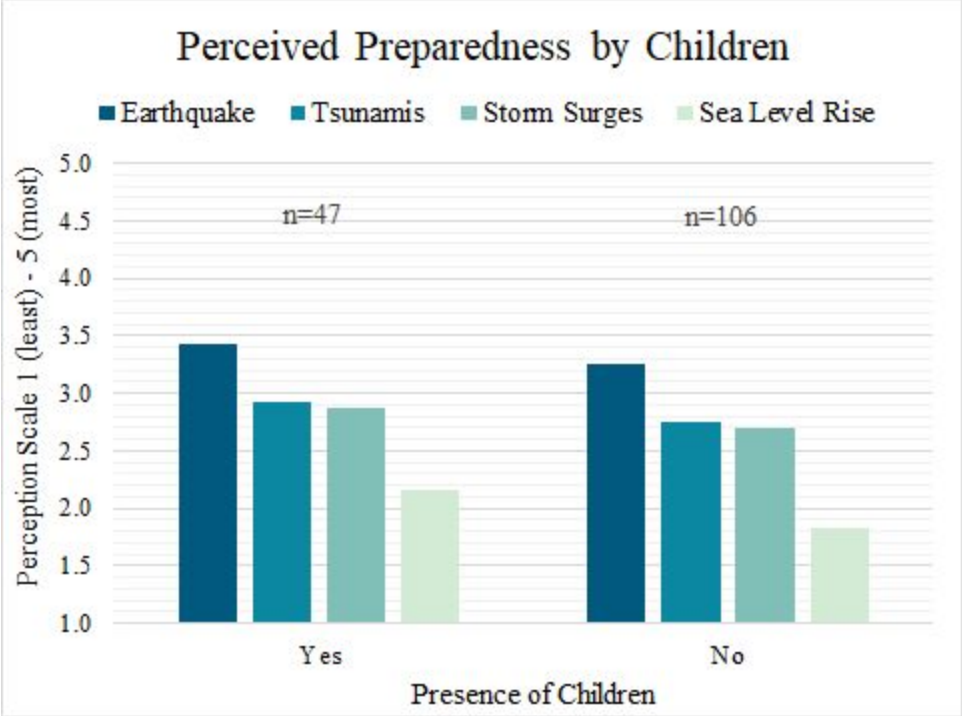




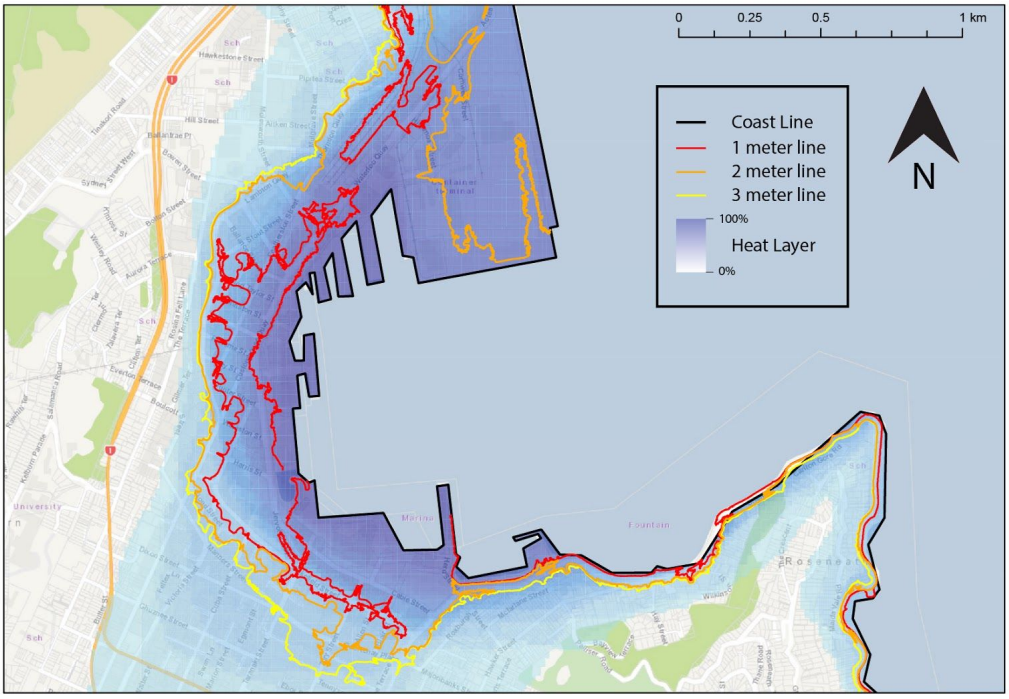

Policy of SLR by Children (n=153)
Yes
No
Maybe
n=47
n=106
n=153
100
90
80
70
60
50
40
30
20
10
0
% Respondents
Yes
No
Average
Presence of Children


Will you be Impacted by SLR by Children (n=153)
Yes
No
Maybe
Next Generations
n=47
n=106
n=153
120
100
80
60
40
20
0
% Respondents
Yes
No
Average
Presence of Children


Perceived Risk by Children (n=153)
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
n=47
n=106
Yes
No
Presence of Children


Perceived Preparedness by Children
Earthquake
Tsunamis
Storm Surges
Sea Level Rise
Perception Scale 1 (least) - 5 (most)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
n=47
n=106
Yes
No
Presence of Children

Appendix K: Heat Map



Appendix L: Interview Transcription-Judy Lawrence

Alex: [00:00:00] And I think we're all good so we'll leave this running.

Amanda: [00:00:04] So I guess our first question is just trying to understand a little bit more about your background and how you came to be where you are today. So, how did you get into environmental policy and communication?

Alex: [00:00:17] Share as much as you like.

Judy: [00:00:21] So I was the first girl who got into this in a big works department years and years ago. And got into water and soil management. I was geomorphologist, trained here, that was my background. And so I worked in local government regional water, soil sort of area for quite a while. Ministry of the Environment was set up end of the 80s. And I went in as a foundation manager to that. So I had a period of working in the government policy, you know, and then I went off to another policy area and then I came back and headed up the climate change office in the government for a couple of years and then I went consulting, and now I'm doing research in sort of a hot area on climate change, particularly adaptation and impacts is my sort of area now. And I'm funded through the Deep South. Yeah. So there was some challenge on four projects over the two of them.

Judy: [00:01:23] So my own doctoral research was looking at the adequacy of our institutions to deal with climate change adaptation and decision making. So that was sort of my focus. So working on research a bit wider than that, obviously, as you do. I am going to be part of SeaRise program for Tim, so there's a bit of conflict of interest, so I just wanted to say that. It is a fairly small part in that particular project, but it is around this question of, the tools and how those decision making tools can be used to be better informed by the science and the project. That's sort of part of it. So that's probably enough

Amanda: [00:02:18] And so we were doing a little bit of reading about the work that you do, obviously, and it appeared to us that a lot of it is mostly within policy communication, but as well as some with the public as well. Can you share about your experience with communicating and working with policymakers and effective ways that you've done that

Judy: [00:02:46] My successful work, I think, is where if you're a researcher, and needed in a decision process and I've had two experiences recently with that. One was the paper we wrote up

- I did with Maralyn Hashnoop about using simulation games and we - Marylynn approached me back in about 2012 - and was aware that we were dealing with this issue of how do you deal with uncertainty and change in decision making? And so we teamed up, and we used the tools, we got some funding to modify it for New Zealand, slightly. We've done a coastal game which was more particularly designed for New Zealand. And so, you two parts to this is using simulation tools to actually give people an experience which is outside the their lives- its a safe place.

Amanda: [00:04:00] Yes yeah.

Judy: [00:04:01] So quite an important thing. And also, where they can role play and have negotiations between different interests. And that was probably the most successful part of it, and what people liked the most when we did the game. Yeah. You know, they would simulate four periods across 100 years and they would work out what options they want, and then they would negotiate them with the other tables. Like, they'd get a person from each table up front and they'd negotiate. And they'd come up with two options, because that's how the game is designed, and we'd put them through the simulator, and you get feedback and that gets translated into hydrograph and you know, how it affects drought, how it affects public safety, etc. And then that feedback, as well as other information we give them during the game about social processes occurring. Like, you've got changing populations, you've got changing groups within populations, you've got numbers as well, and you've got different social things going on, like funding. Or you might get a flood, and so that changes peoples perceptions along the way, and feeds back into the game. And then, when they do their next period of the game, that influences those decisions. It makes them think about the future. By the time they get to the second round, they're realizing that 100 years is quite significant for what they do today. Because they're making investments that'll last 100 years. So, the take-home message from that experience to me was that, its most important to get all levels of the decision making process involved in that. First time we did it, we did with the Techies, like the advisors. With an organization. The second one we did a game with the politicians and some of the Techies, and the Worcester people, you know actually a couple of guys from the Worcester program sat in on that and participated.

Judy: [00:06:12] What else... The other take-homes were that the organisation that is managing the decision process has to have some champions within it. And in this case, it was the manager

of flooding, who was really interested in upskilling has staff with the latest information. IPCC had come out and you know, its pretty high level for people working on decision. They need a bit more. How's it going to affect my area, and we want numbers. And we say, well sorry, we're not into a numbers game, this is not about numbers, this is about how do you deal with uncertainty and looking across a range of scenarios and visualization, and thinking. So the game really helps people have an experience which forces them to think long term. If you do it often enough they can - they sort of get it. Some of them get it. Some people don't. Some people need it reinforced many times. We've just - I've just been up overnight on another project in Hawke's Bay where they're developing a coastal hazards strategy and they've used the Tool - the dynamic adaptive policy pathways in the process and done it alongside the motor criteria analysis. It will be another paper that we write up in terms of what worked, what didn't work, and what sort of decision did they get to. We did the game with the technical people at the start of that process. One of the things that got in the way of that - I think - was that we got in a bit late into the process. The consultants who were working for the council had already set up the MCI processes and there were a little bit - there was a little bit of this building trust stuff going on - and they were a little bit ho-hum about the game, and I don't think that they suspended their judgment, actually. And I think you have to. You know, if you're role playing, you just need to get in there and do it, not analyze

Alex: [00:08:28] So in this game who who was involved? You mentioned a couple of groups of people, you said that there were some policy makers and some others as well

Judy: [00:08:43] We did it with the Regional Council of Wellington. And there were planners, coastal people, catchment people, there were engineers, a bunch of sort of people across the different disciplines. The City Council was there. We got in the New Zealand transport authority guy, because in the particular project that we knew that this was going to was sort of priming for, had a bridge. And the bridge is a chokepoint on the river. And the road had to be changed, so they were involved in the process because it was the state highway. Yeah. Yeah. So we basically got people in the room who were the advisers on those sorts of issues, plus on wider water issues, I think someone from what is now Wellington water at that meeting as well. Then we followed up with a similar sort of thing with the politicians. Okay but we also brief the politicians well

before the game. So, they wanted to know what the impacts of climate change were going to have on the river scheme because they were just completing that part of the scheme. So we were invited and were privy to quite a few of the discussions and the questions that were asked by the politicians, which gave us a good insight into potentially what might be successful in trying to communicate with them. But one night I gave a presentation while they were having dinner, we were sitting around a big room, and I put the visuals up, we went through the process, and that motivated them all to say oh, let's do the game! So that was great.

Judy: [00:10:31] So I think that you know the take home - the sort of key learnings about communication - is that you've got you almost like - I call my role as being a bit of a broker in the process. Some sort of intermediary between translating the high levels science, and the principles that come out of that, through both a game and a process that they could use in any real life decision. That all required them trusting the people that were asking. So you develop a relationship where you do that. I mean, I knew a guy, but I hadn't worked with him, so you know I briefed his staff as well. So there was a team of his team of people we were working with. So thats at the technical level. Now, we've not done a lot at the community level except this project at Hawke's Bay with the councils. It's a very interesting project, actually. But there are three councils they have a joint committee and then they have these community panels and we had a process going all last year, last night was the 12th workshop. I haven't been to all of them, but I've been to the critical ones, and last night was a critical one, because it was having a conversation with the people who were in imminent threat of - well, some of the houses have already been trashed by the gravel and waves - but that's Hamoana

Judy: [00:12:35] So we're trying out different methods, and it's really the first time a big consultation like that has really taken place in a coastal area here in New Zealand. And the same way there's been other projects around, but plenty have done some stuff around June restorations and things like that, there are odd few around the country but this is probably the first that's more systematically following a process with community. And my view, is that that needs to happen. There are some things that are better done in the technical environment, and because the Wellington one we did the MCA process just with the Techies, and they didn't involve the community other than having open days and there's this quite a quite a sort of good system of the

regional council in Wellington, running open days for flood staff, and I think they could do that more widely on coastal, and I've suggested it to them. But now that the coastal Hazards guidance has been released, and that came out in mid December. And there'll be a rollout, and we'll use a mixture of presentations. We're trying to design some exercises that people go through the process they're then, well okay, how do we use that in our planning process? how do we convert that into rules that are legal, and that sort of thing

Amanda: [00:14:15] We were reading that you did a different sort of outreach strategy with the community last year, there was a lecture series - or maybe just one or two - that you did with one of economics professors, whose name escapes me, but about who is going to pay for sea level rise.

Judy: [00:14:34] Ah right. Well there was Jonathan Foster. We did that - well basically, Jonathan had been working on this whole question, well he's written a book on planning for the future, or something like that. And there's a whole lot of stuff in that which has relevance for how to deal with deep uncertainty and he came to Washington with me for a Deep Uncertainty Society conference a year ago, and we did some presentations there because I thought that, you know, in my my international, my global network, there wasn't a lot of discussion about governance and governance is actually key

[00:15:30] There was a bit of a coincidence of interest because we had been thinking about well, who pays, and that side of it. We were - I was quite keen to build on what Jonathan had done and then link it through to who pays for the sort of effects of sea level rise really we concentrated on you know, but it's broader than that. But there's a whole lot of issues in there about - you see, at the moment we have a Damages fund which is a post-hoc thing; it's after damages have occurred. It was set up after the Napier earthquake in 1931, well a bit later than that but that's partly the reason, and so its for dealing with any major catastrophes. You know it's a catastrophe fund effectively. And its underwritten by underwriters internationally it's all risk managed and that's it. It's a world first actually, it's one of the things a lot of people are interested in. Leaving that aside, that deals with after the event. They we're looking at well, how can you actually help fund people to do adaptation before, to avoid risk. But that raises all sorts of issues, like moral hazard - if you pay people to do something that they would have otherwise done, you basically can

potentially incentivize people to do things that are not in the interests of reducing risk. So it's quite complicated to design. So Jonathan's got a big brain and he was very good on this stuff. So we said, why don't we run some workshops? But this was principally with the interested parties, it wasn't with the community. It was with policy wonks and lawyers and local government, and people who have some interest, insurance industry, all those sorts of people.

Alex: [00:17:52] Yeah.

Judy: [00:17:53] And then subsequently, we put together a discussion paper and Jonathan and I were talking this morning about - I've just said to him - we really need to get something out for the average joe blow on the street. So we're going to do an article in policy quarterly. I also would like to do a little policy brief or something that can go on websites and we need it on social media or something.

Judy: [00:18:18] Which brings me to another point, which is the use of social media in also LinkedIn, which I use for professional stuff, and some people don't, they use it for other posting family things on it, which I never do. That's Facebook.

Judy: [00:18:38] But what happens with LinkedIn, and I love, is because people will post a new paper, like they did last night, Suzanne Mizoram of America who works in this sort of area, she posted a really nice paper by an Australian guy. And I think, oh that's great, I'll put it on mine. So I linked it to mine. So that's a really good way to get other professional's interested. But in terms of communicating this stuff to the public, it's a different ballgame.

Judy: [00:19:18] Yes, and last night, even at the meeting I was at, there was a group in the room who had not had the benefit of some of the previous briefings, and the temptation to reinforce people's expectations of protection is a very high. And there's the literature around this.

Amanda: [00:19:39] Yeah.

Judy: [00:19:42] And I watched that from the room happening last night. And there was one point where I called it. And I was acting as a researcher, friend of the process, if you like. And there was some conversations going on from both technical people and the community which was just discounting the future, and they were all hitting themselves back into talking this way. And so I brought them back to what the objectives of the strategy were. I thought it was the clearest way of doing it, so I didn't come across as criticizing what they were doing, which is

important, because they've got valid views, but they just have to get through a long processes of understanding that if they do something now, it could compromise something in the future. You know, the conversation went something like, Okay if I have a protection, whatever the protection structure is, that means we can change the district plan, and we can loosen the requirements. So, it's giving them a false sense of security because with sea level rise, its not going to stop

Alex: [00:20:57] It's a temporary protection, but it's not long-term.

Judy: [00:21:00] Exactly. And I head to state that, what you're talking about here is temporary, and so you have to reinforce some messages constantly. So it's it's tricky. And we also saw gaming. There's been two meetings, or three meetings really, where there's been quite intensive gaming. What I mean by that is, people in the room basically when they're going through a technical ranking score, or through MCA for example, they're giving different scores - they're not consistent. Because they're wondering a particular outcome. So the numbers are up there and they can see what's happening - they're not stupid. They can see what's happening to the numbers, and it's not going their way. So they'll game it. We weren't talking numbers last night, but the same process was going on, in terms of people's reactions to each other and reinforcing things that these others would say because it would be beneficial to what they had decided, that sort of stuff going on.

Judy: [00:22:09] So in any process, it has to be really almost independently facilitated. And the councils are doing as best a job as they can, but when you've got people who are living in the same community in a small town and they meet each other socially, the politicians are not going to - they're going to let the process go a certain way. But, they have to still live with those people. And so they're also - all those other sceptics stuff is - I mean, they do their best. But I think for processes like the one we've been involved in, you do actually have to have a sense of independence in the process, as much as possible. Yeah. Which implies that you know, all the councils around New Zealand don't have enough resources, really. That's a big issue.

Amanda: [00:23:05] Yeah that's valid.

Judy: [00:23:06] But one thing I didn't mention right at the beginning, and I have to be quick because I've got to whiz downtown, is that I'm also co-chairing the climate change adaptation technical working group of the government. And we've put together, well one of our reports is

out - have you seen it? The stock CAG report on the state of adaptation in New Zealand. It's on the ministry for the environment website.

Alex: [00:23:31] Yes yes possibly. I know there's a couple ones about adaptation that we've read, I just don't remember exactly which one.

Amanda: [00:23:36] What is the one that was it was like it came out during the like the last prime minister's term and it wasn't released until - .

Judy: [00:23:45] Well there were two. There was the guidance was ready a year ago but it wasn't released until December. And then the stocktake we finished in May, and the minister decided that it would be better to have the options report with it. So the stocktake was released on the same day as the guidance. It's on the website, but that would give you a very - I mean, it's very simply written. You know, it's got a framework around, that you need to have information, you need to be organised to use the information, and that's in governance and systems and processes. And then you also need to be thinking dynamically. So about the future. And so that's the framework we set up, and we've now got a report which we socialize and holds a few key people at the moment around options.

Judy: [00:24:35] I can't share that one with you, but yeah it will be out hopefully in, well, we're not sure when it'll be out, its up to the Minister really, the new Minister. So what I'm saying is that in those reports, we've tried to address some of these problems. We've got a section on capability and capacity, which has to be addressed, and you know what sort of, you know, the government has announced it's going to have a climate commission a bit like the UK one, which will deal with the emissions reductions. I don't know if you know the UK system, but they set targets and they ratchet down and they report it annually and they have a show and tell annually if government's not doing it and at all that. And it has an adaptation sub-committee. And so I think the Minister hasn't made the final decision on it yet, but I think he's certainly made it known that it's a good idea, but quite how it's done I think they're still working through. Yeah. Anyway sorry I'm getting slightly off topic but that's a bit of context as to what's going on at the moment so adaptation is getting a bit more airtime.

Amanda: [00:25:44] Yeah. Interesting. Yeah.

Alex: [00:25:47] I thought I had a question coming on but I'm just so sorry its left my head.

Amanda: [00:25:55] So you mentioned that there the public just need to be pretty consistently reminded sometimes of like the basic the facts of things like sea level rise is not temporary. Are you noticing a lot of like push for or against policy changes for adaptation from the public? Or does it change based on where they live or how they're affected by it

Judy: [00:26:27] That's quite a hard question. And also, things change. And the change of government I think has made quite a bit of difference. There have been groups in the community in the past who've just basically thrown their hands up, like what the heck's going on why are we doing more? A lot of a lot of airtime has been given to emissions reduction. Not much on the adaptation space, except by local government, who are having to deal with the problems. And we have perennial floods - more than two floods, three times a year. You know that's that's a big big problem. And drought. Drought costs the country lots of billions.

Amanda: [00:27:08] Yeah with all that farmland, that that makes sense.

Judy: [00:27:11] So economically, these impacts are quite significant. But the farming community has got support systems which reinforce non-avoidance issues. While the governments sort of ratcheted back, and it's pretty tight to get that money, we've had true drought areas this year. One on the West Coast over Christmas, and one just this weekend - I think it was announced on Monday - for Saffron. So that means they can get money up to a certain amount, its not much, but it's sort of like you deal with the problem when it happens. So going at your question, the push back there has been push back at the political level, and still is, in some other some councils. This government we've got now is on board with dealing with climate change. Yeah, the last one was somewhat ambiguous, I would say, would be the word.

Amanda: [00:28:24] Yeah, that's what we've heard.

Judy: [00:28:27] On one sense, they initiated work, but on another, delayed release of the document tells a story.

Judy: [00:28:36] Hum yeah but there are other community groups within New Zealand like down in Dunedin, where they had a big flood in 2012. They've got a stretch of low lying area sort of a mix area of low income, region housings, and so on. Water comes up the tides and that's a problem. There's a community group being funded to work councils to come up with solutions across the community and that'll probably be the next place where they use some of these

approaches. The councils in some areas have made some decisions which will be them for a very long time, and it raises questions, well you know who pays for the damage in the future? So there's some legal issues, but there is a lot of research now going on on some of those issues around the role of insurance. How would you legally with existing use rights under the law? Property rights and that sort of thing. There's quite a bit of attention to infrastructure and what do you do, do you design different types of systems? I mean, someone needs to do some blue sky thinking about infrastructure.

Amanda: [00:29:49] Yeah absolutely. This is actually interesting, because we've got a lot of feedback about that just as we've been out surveying the community, and we've had a lot of respondents just within the public, like one of our questions...

Judy: [00:00:00] Councils to come up with solutions cost the community and that would probably be the next place where they use some of these approaches. The councils in some areas have made some decisions which will be with them for a very long time and that raises questions, well you know who pays for the damage in the future So there's is some legal issues. [00:00:21] There is a lot of research now going on, on some of these issues around the role of insurance. How would you legally with existing use rights under the law. Property rights, that sort of thing. Yes. What else. There's quite a bit of attention to infrastructure. And what do you do? Do you design different types of systems? I mean someone needs to do some blue sky thinking about infrastructure.

Amanda: [00:00:47] Yeah absolutely. This is really interesting, you know we've gotten a lot of feedback about that just as we've been out surveying the community and we've had a lot of respondents in that just within the public, like one of our questions on the survey is asking whether they believe that some policy needs to be enacted to respond to sea level rise in Wellington and we've had an overwhelming positive response to that. And usually the follow up question is stuff about a fact it's like are we going to be able to be insured? Like. What about the infrastructure and the city? Stuff like that.

Judy: [00:01:14] But the interesting follow on question - and I don't know that with you finished your surveys - is well, yes, people want something done, but when it comes to doing something - and we found the stuff in Hawkes Bay - they all go for raising the roads, and putting in seawalls,

and not thinking long term as to whether that's the best option or the best investment of our money or would it not be better to put that money in the bank and use it for something more transformational? Yeah. We have to be thinking outside the square about this stuff.

Amanda: [00:01:46] Yes.

Judy: [00:01:46] Because it is going to impact, and it will be a huge impasse.

Amanda: [00:01:50] And a follow up to that is what we've found that has been really interesting is this just belief - and I know there's a word for it and I don't know what it is - but this just like all encompassing belief that somebody else is going to do something to manage it.

Alex: [00:02:02] We've seen a lot of that

Judy: [00:02:03] Yes, yes - transference, I think its called

Amanda: [00:02:05] Yeah yeah, I think it is, too. Just like, this believe that, you know like one of our questions is just very open, very generic, will sea level rise affect you in your lifetime? Like personally you, and how you live. And so we've had immediate yes reactions and immediate no reactions we've had you know, maybe not me, but my children, but we've had like a lot of. No I think like somebody will do something about it. Like, the ambiguous "somebody", which has been really interesting.

Judy: [00:02:33] I mean something I've also noticed is that I mean, there's not a lot individuals can do. Some things they can do is to make sure they find out about the risk in the particular locality before they purchase property.

Amanda: [00:02:48] Yes.

Alex: [00:02:49] It's like protecting investments. That's just rule #1.

Judy: [00:02:52] And also have some pretty heavy discussions with their banks and their insurance companies about their premiums and so forth, because you know I know my own behavior about insurance is to try and get my premiums down, right?

Amanda: [00:03:03] Yes.

Judy: [00:03:06] So it's, yeah. Because at the end of the day, it's got to be a sort of community understanding and a partnership between the responsible parties to do something and that's central and local government. But yeah around Wellington there's certainly issues. I live across the harbor and over the summer there were more storms at high tide. We get them regularly ever

since we've lived there. The question is they'll become probably more regular. And the levels are getting higher with summer and during tidal equinoxes. It's going to be interesting to see what happens tonight because - did you hear about it?

Amanda: [00:03:43] Yeah, the super blue moon! We'll be out seeing it.

Judy: [00:03:51] Yeah, me too! But you know whether that has any sort of influence on the tide today - because it was pretty high last night. You know, so this sort of there are some long term issues. I mean my access where I live will be cut off - I live up on the cliff - but yeah the access will be cut.

Alex: [00:04:07] But the infrastructure below that's impacted.

Judy: [00:04:09] Yes that's right. Everything comes up from the bottom. It all goes along- my broadband, my everything. So you know, we need to rethink our lives to the future.

Alex: [00:04:20] Yeah seems like there's a lot about changing people's - its a shift in mental focus.

Judy: [00:04:24] It is, it is. And that's as much about how you frame the problem

Alex: [00:04:28] Yeah okay. [269.5]

Appendix M: Interview Transcription-Dean Peterson

Alejandro: [00:00:01] Okay so, I'm telling you a bit about our project. We're working with the Antarctic Research Center on our project is about basically creating outreach strategies to help them communicate with the public in regards to sea level rise. The first part I was working on is collect data from people on the street to see how they think or how they perceive the risks of sea level rise and also talk to experts or have a lot of experience in outreach like how to talk to people how to convey science communication and try to learn a bit from that in order to develop our own outreach initiative.

Dean Peterson: [00:00:47] Oh yeah.

Zach Weiland: [00:00:49] Yes so the puprose of this interview is to talk to you because you are so involved in Te Papa and in making the exhibits so we figure that obviously museums and other installations are a very importat part of science communciation. So we are trying to trying to understand and get your perspective and your experience in the field.

Alejandro: [00:01:30] So first of all we would like to know if you could tell us a bit about how did you get involved with Te Papa and in public communication.

Dean Peterson: [00:01:39] It's a long term story I suppose, I am so I got a Ph.D. in chemistry along time ago, nineteen eighty eight finished with my Ph.D. I went to the Jet Propulsion Laboratory California for ten years and three of those years I was back at NASA headquarters in Washington D.C. And I think so I went from being a scientist to a bureaucrat or to industry. [00:02:14] And that started to shift me into more public dealing with science communication I then ended up coming to New Zealand met a woman.

[00:02:30] She dragged me to see. And I ended up being the science manager for the Antarctic program down in Christchurch. I did that for ten years. And that had a big science communication factor with it. it was more mostly around coordination but there was science communication from that I went and worked at the royal society of New Zealand which is kind of like the national academy of science in the States. And there I ran a big research fund called the Marsden fund and then I went to Calahan innation which is a around innovating things. I worked there for two years and then I came and I've been at Te Papa for about a year and a half so not that long. But what drew me to te papa is A. it's the national museum. B. It's got a very

large profile and it's a big voice for communication. We get at least one and a half million and last year we had one point seven million visitors through. So it's a big it's an it's a really good place to communicate research. And when I was hired they were just starting updating the process of natural history section of which we're involved with which is quite exciting. If you go through the museum what's there now for natural history has been there for twenty years. We're changing that out and putting on a new exhibition.

Alejandro: [00:04:16] That's been there since the beginning right.

Dean Peterson: [00:04:19] Yep, Most of it. I mean there's been a little changes but like giant squid came later.

Alejandro: Yes we saw saw

Dean Peterson: But that's still been in there now for over ten years.

Alejandro: [00:04:32] So you were saying that Te papa has a big voice in terms of public communication. We were wondering what's the museum's goal in terms of you know communicating to the public what's the underlying goal.

Dean Peterson: [00:04:45] Well is there one, there probably isn't on, no. We want we want to continue to be a trusted voice okay. So it's really important to us. We've done quite a bit of survey work in the past and you know the public trusts us, what we say they believe is real and truthful so that's really important that we continue that. The other thing we want in terms of goals is to have the public especially with the new exhibitions have the public better understand nature and also comprehend how they can how they can make a difference.

Alejandro: Great

Dean Peterson: So we're in the existing exhibit right now. We don't talk at all about threats. In the new exhibit we're going to have a climate change section a sustainable oceans section, a freshwater section, a pest Control section.

Alejandro: [00:05:40] That's more empowering.

Dean Peterson: [00:05:41] It's more topical and it's yeah it's empowering, exactly. People make a difference.

Alejandro: [00:05:46] OK. Do you think that's how that approach is better tha telling them what threats are.

Dean Peterson: [00:05:53] Well I think it's yeah it's definitely if we just talk about the problems of climate change, and what happens immediately is people switch off because they feel like they can't do anything. Its too big it too massive. I can't make a difference. Why do I even bother. And of course if everybody take that attitude then they won't make a difference.

[00:06:16] So,we want to get out of that that we want to put to them a very simple explanation of climate change but we want to do it in a way that then gets them interested in that decision.

Zach: has that decision kind of come up through Te Papa as an organization or have you brought that from you background as a science communicator?

Dean Peterson: [00:06:48] Umm, it's a bit of both. Its not, Look a lot of that is a lot of these ideas have not just come from me by any means. There's a huge group behind this. There's about thirty five of us that are working almost full time for the last year an a half

[00:07:01] We will be continuing through next year with. So it's a big huge project. It's so well known in the communication area that there are three three things to do with an audience. You need to, let me get this right. You need to let them know. The three words are know. If I had them in front of me I could remember it. It's know, connect, and change.

[00:07:42] It's not quiet that but you understand. So the know is around understanding the knowledge connections around a physical or mental connection with things you know get that bond happening and then change it's OK now what can I do. How can I make a difference. So if you get those three objectives cross you've made it. so the first thing you do is try and get that emotion that connection and then people are then all of a sudden willing and they want to learn more and when learn more they hopefully could figure out how they can make a difference. Maybe more accepting of trying to make a difference. And there the other subtle things thats going on background is we don't want to make it really obvious. We want you to come up with that conclusion.

[00:08:33] We want to make it so that you always come up with the same conclusion no matter who you are. So you know there's manipulation going on.

[00:08:41] It's a subtle thing.

Alejandro: [00:08:45] Interesting. So you were mention these are sort of strategies that has to reach out to people. You mentioned the three steps and also focusing more on the, less on the

threats and more what you can do. Is there anything else about any sort of strategies that have worked for the museum in the past.

Dean Peterson: [00:09:06] We also want it to be very interactive so we know that people only really learn things by do you show them. If we just show them stuff and you know even beautiful graphs and beautiful visuals. But they aren't actually connecting or doing, they won't learn as much so it's really important to make it social. So if it's let's say the three of us went to the museum and I did the interaction and you did the interaction, and you did separately we wouldn't learn as much and we wouldn't have as much to talk about afterwards as if we do it as a team.

[00:09:48] So we create interactives that are social in that there are more than one person doing it and you know we don't have to know each other.

[00:10:01] That's not that important. It's just that you have teamwork happening and you will learn it better.

Alejandro: [00:10:11] So what would you say are the key aspects of a good successful exhibit.

Dean Peterson: [00:10:18] There is going to be highs and lows dynamic range is really important. So what you don't want to do is you know having the rollercoaster screaming the whole way through because you'll either freak people out or you'll bore them. Even though it's screaming you get board of screaming after awhile. So you need the highs and lows in the exhibitions, that that's really important, visually it has to be interesting.

[00:10:47] It has to be really obvious. So what I mean by that is to be quite simple.

[00:10:54] We can't talk about fur like sea level so we can't talk about the sea level has to do with isostatic spring back of the of the landmass that the ice is coming off. You can't start talking about that stuff because everybody just goes one ear and out the other. They're not interested anymore.

[00:11:17] So messages have to be simple. There has to be an interactive visual stimuli but it can't be too on one level. We have to have highs and lows.

Alejandro: [00:11:28] OK. And also during our research we've come across a very big range of demographics. How do you do it at Te Papa to target different demographics targets.

Dean Peterson: So we will do two different splits of audience.

[00:11:52] We do not just simple age brackets. We look at age. We look at ethnicity. That's simple one that we do, age and ethnicity. Or sometimes which is actually put together by the museum sector it's a is a. I don't know these terms it's based on your psychographic dynamics.
[00:12:39] Its the expression, expressionism, are you expressive. are you. Are you…
Alejandro: Introverted?
Dean Peterson: No it's not. It's not quite that direct. Are more around expression.
[00:12:56] You're interested in stimulating things so you take there are you. Are you daring. There's is more heart rates Oh psychometric breakdown if you look that up if you could find the data and I think there's nine categories.
[00:13:17] We focus on four because most people fit into four character expression stimulus I can't remember the other two.
[00:13:28] But there is one around inclusiveness. So if I'm the type of person that makes sure that all my friends will join us also. So that's the kind of inclusive person where they wouldn't want to go and he said I'm scared of dark we wouldn't go to this exhibit because it's really dark.
[00:13:54] But those different categories which are psychometric categories we use that in some other way to figure out who would enjoy the exhibit and who we would be attracting.
Zach: So,how did Te Papa come up with those three demographic groups; age, ethnicity, and the psychometric groups
Dean Peterson: [00:14:28] Well there's only so so many ways to splice up the population and we do have a mandate from governments around Maori
[00:14:37] So we need to we need to ensure that we have people coming to the museum that are have a maori background.. That's so that's an important measure for us. We also look at the Pacific. So as the population of New Zealand is roughly 14 percent Moari, 4% Pacific we're right now sitting on visitation it's like 12 percent. It's a little bit under represented but we're at 4 percent. So we're in the demographics and we want to stay there. We'd like to of course if we can. So we do deferred events where were we really target them. In the renewal of the Natural History renewal that we're doing right now there's enormous connection with Maori which is looking at the knowledge base as it fits with science. That's a very important connection to make. So we feel we draw stronger, a higher level …..

Alejandro: Have you ever, at Te Papa, organized any events or exhibits, perhaps with other Wellington organizations?

Dean Peterson: [00:16:14] Yes we do. We do a lot of events with others and we do a lot of events for others. Um what's a good example. We're doing a bio or citizen science conference symposium its kind of a big game in mid April this year and that will be in conjunction with citizen science organizations. So we are running that there and they will be contributing.

Zach: [00:16:51] If Te Papa continues to keep implementing this collaborations, would you say they that are successful for both sides.?

Dean Peterson: Yeah I mean it's a way that we can get a lot more for our money, yeah. [00:17:09] Also we bring in expertise from other sources. So another thing that we did recently was we ran a whats called a lab ina box. the lab in a box sat down in front of Te Papa right there. The area that was run out of the something and also the through first connection with Victoria was kind of through.

Alejandro: [00:17:38] I was very interested by how you draw how you attract different demographics. I was thinking in terms of for example the exit exhibition from climate change because it's related to our project. How are you planning on bringing say Maori or pacific peoples. Is that a general exhibit for everybody or others?

Dean Peterson: [00:18:00] Yes some actually. Well we'll keep going here then I'll show you the exhibit. The exhibition what it does is start out in a prehumen new Zealand.

[00:18:14] You come in, prehumen New Zealand and then you go into what's called unique New Zealand, unique NZ and that will be showing you all the flora and fauna. Not quite the usual Museum Way but much more museum ish, stuffed animals things like that around the edges with some amazing visuals. But a lot of the floor will be about the flora and fauna. Then there's going to be an active land part which will be much similar to the awesome forces in that it'll talk about the earth and so on. And then you come into an area called nest, the nest will be look like a nest and it will be a big nest that you can walk around learn about the birds. We will have circular panels all over it with eggs that you can push, the egg and then find out the species whether it's thriving threatened or extinct and you go through that and roughly what weve done.

[00:19:27] It's true that the endemic birds here inNew Zealand it's about of third a third a third situation so you quickly realize of problems with native species and then you come out of that and go into the pest control. These are all connected. If you go the route that we like the preferred route for the visitor which looks fine come up with a pest control, freshwater oceans and climate change. Change to climate change is kind of all encompassing. So back to your question it isn't that you would we would specifically target some people to just climate change section. We will try to get them to go through the whole thing. There will be connections to the Maori through the whole thing.

[00:20:21] So that will hopefully attract that demographic.

[00:20:28] We also we went with a number of us here to talk about two months ago and pick collecting field trip there where we talked with local people videoed a number of them but they also gave us a number of items to bring back to Te Papa for collection and also for exhibition. We will certainly exhibit that in climate change in particular because there are three atolls that are just about underwater.

[00:21:02] So that will bring us closer

Alejandro: [00:21:08] Well and have one open ended question so in the knowing the context of project related sea level rise. Is there anything else you'd like to tell us.

Dean Peterson: I think keep it simple.

[00:21:28] You know that's that's the key to making efforts and getting getting that idea across. You know. I don't care how many times I tell people the Antarctic and the Arctic ice sheets hold 60 metres of sea level rise no one really comprehends that there's actually 60 meters of sea level rise. There are a lot doubts. I mean we will be underwater here. I'm about 40 metres even here at this level three.

[00:22:07] It just doesn't sink in.

[00:22:08] So you know in fact for myself I had to sit down and say well what’s the size of the Antarctic, what’s the size, how thick would the Antarctic ice sheet have to be for this type of sea level rise. And it comes out to be 4 km thick, that’s how much sea level you get out of it. So I guess what I’m trying to say is keep the message simple and that's what's good. I think people

understand it more. Not so much sea level rise. But what we just saw yesterday is storm surge and storm surge on top of sea level rise. It really does huge damage extension.

Zach: [00:22:55] I mean we just had a talk with Tim and assuming the 50 year projection works out the 100 year stomr would happen annually. Its something that people, at least something I haven't fully rapped by head around yet. Speaking of which, how is Te Papa prepared to handle storms surges being so close to the harbor?

Dean Peterson: [00:23:24] We're not something. We, so one thing we have done here is we don't have any our collection items on the first floor..

[00:23:31] Nothing. So that you know if we really are hit with a major wave we should every second floor or above.

Alejandro: I realized this later.

[00:23:42] There you go upstairs right when you come in.

Dean Peterson: [00:23:46] There is nothing there and it's been built that way on purpose. More important for us here because we live in Wellington, that the building is on an isolated basis layers so when it shakes it doesn't this place doesn't change although it does shake within the earthquake takes a lot of it doesn't it doesn't shake a lot just a little.

[00:24:15] So that's one take. They spent almost a year pounding the ground underneath ,you know to structural stability. But in terms of sea level rise you know Wellington is not really prepared for sea l level rise..

Zach: [00:24:44] Yeah. Something we've come across in our research that people aren't aware of that the GWRC is starting to think about that and they are in the appeal phase of developing a plan for the greater wellington area.

Door opens and we have to stop the interview, we move rooms and talk about the climate change exhibit

Appendix N: Interview Transcription-Rob Bell

Alejandro: [00:00:01] So basically our first question is how did you start? How did you get into coastal oceanography

Rob: [00:00:10] Coastal oceanography. So, in New Zealand we don't have a coastal oceanography course or degree, yeah, like you do in the States. So I did civil engineering. So that's my background. That's I guess where the few coastal engineers who work in New Zealand have come out of the civil or natural resources engineering. So I started out doing water quality and coastal marine work, also been doing a lot of dispersion modeling, designing ocean diffusers. Doing a lot of field work using current readers and so on. So, and then that developed the need to understand tides, and sea level, and currents, all of those things. So I learned a lot of it on the job, as we say here. And in reading textbooks and what you observe in the field. So you actually learn a lot by observing currents and chasing drones around, around doing guide studies.

Rob: [00:01:35] So that's where it all started, and then once the climate change issue came up there was a natural progression onto looking at sea level rise because most of our work is actually... I have done a bit of modeling of currents and so on but I tend to focus more on sea level variability, storm surge, tsunami, tides, all those things. So there was a natural progression into looking at sea level rise, which popped its head up about 20 years ago. So that's why I'm into the sea level rise.

Alejandro: [00:02:16] And following that natural progression that you were saying, It seems based on our research that you have a big role in terms of communication, not just within the National Institute of water but also in general climate science in New Zealand. So we want to know how did that happen, how did you go into to the communication aspect

Rob: [00:02:39] A lot of its being done through what we call government guidance. These are in the statutory process. It's kind of Environmental standards and policy statements, but. In the climate change coastal climate change arena, where the government has tended to go with guidance, so they like the technical manuals. So, I've been involved in all of them. So the first one was in 2000 and then 2004 and 2009. The recent one was released just before Christmas. So they are more around how do we do this, how we do risk assessments, had do hazard assessments. How do we do adaptation. So, the early ones were sort of more based on climate

change drivers and the impacts, and a little bit on the implications, but that's a role in my portfolio to sort of span policy, planning, engineering, as well as science, to provide a more well-rounded, holistic approach. And pulling in appropriate people like the latest guidance had social scientists, some physicists people, and planners, to fill in those gaps.But I do straddle those areas. And I might just add that one of the things that I find to keep myself grounded is I still do a lot of engineering consultancy work, some coastal engineering. So I get involved in roading projects, airports, some of their infrastructure development. So that's a way of seeing what I do, what's needed, and then drawing them into saying well what about climate change, and how can we do this, how can we we adapt, how can we stage this road so that we've got an adaptive approach. So while I am producing central guidance, that goes down, I'm also working from the bottom up.

Alejandro: [00:05:11] Interesting, so another question that we have is based on your experience, how do you communicate sea level rise to the public? How is that process?

Rob: [00:05:23] So for me most of it's done through presentations and being involved in workshops and conferences. So, we just had a conference around, and then you're dialoguing with questions and so on. So I tend to mainly work with practitioners. In terms of communicating it, I do do some public talks, but maybe one or two a year. So I'm not - there's no opportunities necessary but I don't seek them, because I've got plenty other work. But there are public opportunities, like I've got a talk to do next month to what they call a gifted children's conference. These are kids around who are gifted and need to extend it even further. And so I'm doing a little talk on coastal climate change. So, seven years now. But to me I focus my efforts on where most of the change can happen. And so I do the practitioners and I've also done quite a number of presentations to councilors at local and regional councils. And sometimes the central government.

Zach: [00:06:49] So since you've done a lot of work with the practitioners and the policy makers, what is your opinion on how aware are the policy makers and public officials of sea level rise and climate change in general

Rob: [00:07:10] I think it's it's certainly improved greatly in the last three or four years. Slightly aided by some coastal flooding and erosion events in the last month or so. It's been. That's

awareness 101 you know, when we have a few events within a few weeks. So that creates awareness. So, it's certainly improved a lot. Whereas before, I'd often be on the defensive, trying to justify marketing changes happening to some audiences or something. But I've noticed in the last couple of years, very few people actually challenging it, now. When I talk or from the questions are all about, what do we do about it? How do we deal with uncertainty? So I think it's it's moved on to how do we adapt and how do we implement? Nevertheless, you still strike people who have a very basic understanding and while I haven't had the question in the last year or two, previous to that, some people, would asked the question, or make the comment, "I didn't even know sea level was rising". After showing them a graph from 1900 to the present it's been rising all the way through that period, "Oh, I didn't even know it was rising". So, but I don't get that quite so much now.

Zach: [00:08:46] You talked a little bit about communicating uncertainty and communicating - what kind of strategies have you been trying to communicate that uncertainty in like, mitigation or methods to respond to sea level rise?

Rob: [00:09:07] So I think things have had a weird shift with the latest guidance. Whereas before that, uncertainty was a scary thing. People tended to - particularly decision makers - tended to say, "Well, you know, it's all very uncertain". Well, I don't want to go down that route to give some best estimate or the most likely, so they said, "we'll wait until there's more certainty" and I kept saying well, uncertainty is only going to increase with the polar ice sheets added to the mix. So. But, I think with the new guidance and the way Judy Lawrence is brought to that, around the adaptive pathways planning approach. And I've been doing it with the coastal engineering and engineering projects before that anyway saying, well let's stage, for instance, stage a roading motorway, roading project, and build it to a certain sea level rise, and then, let's build the foundations and designate the footprint, so that it's wide enough to build it up so we can add some more fight to the road when and if required.

Rob: [00:10:34] So it's a somewhat targeted approach that sort of came out of the team's area. The London team's Flood 2100 project. So, that was already under way, but there's adaptive pathways in the gardens. It's going to be a watershed moment. You know, people are realizing they don't have to design and implement the full system with all response options. But they have

to have planned it out and mapped it out, and then just implement the first pathway, but they have options to deal with that uncertainty. But I think the challenge is going to be around getting people's - in their headspace and that to do that you, have to monitor, and review some signals and triggers. So, we're doing a lot of work around how do you define the early signals and triggers when you have to actually change that pathway, make the decision to change, make it higher.

Alejandro: [00:11:42] Interesting. So it's basically infrastructure that's ready to adapt in an uncertain future.

Rob: [00:11:50] Well that's the roading projects I've been involved with. Its to futureproof - well not entirely future proof in the coast if you're looking looking at hundreds of years - but, in the near term in the next hundred years plus, to at least future proof. If there's surprises in terms of polar ice sheets, then we've got room To move so the Northwich motorway in Auckland has that ability to accommodate another 0.5 To 0.8 of a metre sea level rise. But DNF Garret's agreement works to a certain extent. And maybe we don't need to do that for some time. But either way, this flexibility so you're not locking in a system.

[00:12:47] So we do have one more question for, so Tim Naish who has come in contact is part of the SeaRise initiative and I know that that's in concert with NIWA and other organizations so can you speak to kind of what that SeaRise initiative means for the field and for Wellington Or for what the initiative's goal is?

Rob: [00:13:26] So the SeaRise program is to establish -primarily - to establish a more robust set of sea level rise projections. So in the new guidance, I've essentially adapted Bob Kopp's and the IPCC protections and scaled them down to New Zealand. There is an offset applied to them - that the our regional sea level rise will be a little bit higher - up to 5 to 10 percent higher than the global average. So I've applied that. And then at the local level, with vertical land movement, we've got some data that is in the guidance but we could do a lot better at the local level, too. And then there's the polar ice sheet and the gravitational fingerprint, all of those components that we can do a better job to improve the veracity of those New Zealand predictions. And while we're not necessarily challenged at the moment, I think that it will help provide a better evidence base and cover off some of the more local ones like Wellington is subsiding by up to two or three

millimetres a year at the moment but is that going to continue? Until the next earthquake?. So, and then there's - improving that will help improve the awareness of sea level rise predictions. And there's also a piece of work in there around how do practitioners and end users. How they use protections? And what do they require? And, you know, we've got four in the guidance, is four enough or do they need a whole lot? And around sort of just awareness that no one scenario - like Warren Walker's comment that any one scenario has a zero percent probability of occurring, because as you piece a lot that together you can jump from one to the other to the whole trajectory. That is, the trajectory of emissions and so on. To pan across civil scenarios.

Rob: [00:16:11] Yet when the world wakes up to things getting bad, they might come down on emissions. So how those scenarios work and what they are, and how they fit into planning for adaptation. I think there's some work to do in the communications field around that.

Zach: [00:16:34] I guess so regarding the communication field, from your experience have you noticed any methods from communication fields that you've seen that have worked in your experience?

Rob: [00:16:51] Yeah so I work with some people in the group - in NIWA Hamilton- and with others from other organizations. So that's really around social scientist, and Judy Lawrence. So I've seen simulation games, gaming. The group in Hamilton worked with indigenous people to come up with a called Maori-nopoly. Like monopoly, they had a certain amount of money to spend on adaptation and then the game - simulation game - with cards was around how do we adapt our Maori facilities? So that's where they live, and congregate, and have their cultural identity. How can we best adapt in a confined budget? So, do we spend the money now, upfront, or do we just spend a little bit of money on the worst affected part. So I think with gaming - simulation games - like the Delta game that Judy Lawrence runs - I think that helps with decision makers as well. I think there's a growing need for visualization. And acutely aware that we have some needs in that area, to do a lot more with 3D visualization and what the future response options might look like. I kind of became aware of it when we were in the Hawke's Bay where they were pretty keen on seawalls. But, we pointed out that, you know, if you got one meter of sea level rise and storm surge and waves overtopping, that actually, at the camping ground they would be camping there, but they wouldn't be to see the sea, because they'd be behind this huge

seawall. So some of those visualization things are around what would it look like and how big would it look like, to have a robost sea wall. And there are a lot of other things I know in the Frasier River in Canada. They've done a lot of work in visualization with the Delta community there, around talking about adaptation options like what does it look like in your cartoon, in 3D. In some simulation. What does it look like. What could it look like. I think that would help a lot of the discussions as well. So it's visualization gaming and then of course the traditional. Scientist presenting, but also being available in meetings to rub shoulders and if people want to talk and just ask questions.

Alejandro: [00:20:00] We have one more question - so you said that there has been a big difference when you talk to people you realize that nowadays are more people who know sea level rise. They are more informed than before. So what would you attribute this change to? Do you think the work that programs like SeaRise are helping this change? Or is it social media perhaps? What do you think is mostly influencing that growth in knowledge in people

Rob: [00:20:31] Yes - certainly younger ones, you know I'm not on social media, much, at all, but I guess the awareness has certainly grown through that media. But it has had its downsides because a lot of people have taken cognisance of blokes. And get all kinds of information and I've had to correct a lot of the misinformation that they've scored off the internet. And you know I think some of the global simulation websites, like Will flood watch or something, they have these indicators where you can check out what sea level rise might do in your area. But they're global models and they are very inaccurate. So people are using them for local risk assessments and hazard assessments, or local you know at the house level. So I think there's a lot of misinformation still out there. But to me the key, you know I'm all about implementation, so I'm focusing a lot of my efforts around the people making decisions and making sure they are fully aware and have the knowledge. So rather than sea level rise per se, we're often communicating particularly with decision makers around the number of storms - that is in, the frequency is going to increase - so rather than talk about 30 or 40 centimeters sea level rise which doesn't really mean a lot, we changed tech a few years ago. And so we often use a historic or recent event in saying, that event might've been a 1 or 2% ABP type of event probability. Sometimes we use a 100-year event, but we try to avoid that.

[00:22:37] And we say well, you know, well with 30 centimeters sea level rise, you're gonna get 3 or 4 of those January 2011 events you had in Auckland, you're gonna get three or four hours a year, rather than 50 or 100 years. And with 70 centimeters, they're going to happen every other tide or every week. And to me that that message is being really successful and in the parliamentary, the commissioner for the environment, we help them with some reports. They've been really. Influential. So there was a 2015 report on the science and then a 2016 one when we helped in terms of risk exposure. So they've been really conveying that frequency, increasing frequency, of storm coastal flooding. So it's it's not yet - so its how to convert those sea level rise numbers into something that means something to people. What its impacts might be

Alejandro: [00:23:52] And much for talking. I think that's all we have.

Appendix O: Interview Transcription-Bob Kopp

Amanda: [00:00:00] Excellent. OK.

Amanda: [00:00:02] So yes I guess we can just get right to it. So our first question is how did you get involved in climate science and risk assessment and policy.

Amanda: [00:00:16] Well this is where you can give as much or as little information as you started as we get today.

[00:00:32] I didn't it.

Bob: [00:00:37] So I started as somebody wanting to study astrobiology. I worked on Mercury and then I went around school sort of got warnings of a long term coevolution of late climate. So I worked on snowball Earth and the rise of atmospheric oxygen. But I always had a sort of long running policy interest. I grew up in the D.C. area. My parents both worked for the government. I was active in local politics when I was in grad school. And so when I did my postdoc I wanted to take sort of what I learned about the earth or about the earth system and that it in sort of a more policy relevant context. I did a postdoc in geosciences in public policy at Princeton.

Bob: [00:01:27] I got into so basically doing science but were in more recent science working on things like the sea level rise and critically reconstructing past sea level rise and got a little bit into more policy related stuff like carbon and then I spent two years doing a science policy fellowship through the AAAS American Association for Science at the Department of Energy. So I worked in the opposite of change policy for over two years with the Obama Administration at DOE. I worked on social cost of carbon. I work on international energy cooperation including some work with some folks in New Zealand.

Bob: [00:02:09] And so then I got a job at Rutgers that was in the Earth Sciences department but part of what they wanted me to do is policy and I had sort of carried on this mix of sea level and climate risk. They picked up and started on my postdoc from my time in D.C. For the last seven years.

Bob: [00:02:30] You know when originally those two things were kind of separate but if you're working on climate economics and you're working on sea level past and eventually you'll end up working on sea level change in the future. And then once they started doing projections of sea level rise because we needed the economic analysis other people will turn besides the economists

are now the ones that have some projections they can use got more into working with their state and local groups on sea level rise and then the National Climate Assessment. So that's sort of how I got here.

Amanda: [00:03:09] Oh ok awesome.

Amanda: [00:03:11] Can you also just tire of what your experience with and communicating like you're obviously very technical data and the research that you're doing to decision makers who you don't necessarily have that technical background

Bob: [00:03:27] Yeah so I find that that tends to involve a lot of what's called boundary organisations or boundary workers, or people who are not researchers but are the intermediaries and so the way sea level research tends to have been used and I think this is a little too one-removed compared to the way it should be. But basically it tends to be that the decision makers designed to convene some sort of expert panel and that's a group of scientists in that they give the expert the panel some questions and the scientists answer the questions and then hand off a report.

Bob: [00:04:10] And there's a little bit of discussion back and forth. By and large it's sort of a two step process. And then what I've found is that you know scientists will in that process are trying to do the best job they can to answer the questions posed to them which are particularly like, what is your estimate of how sea level is going to rise

Bob: [00:04:34] But that's not necessarily delivered in a form that actually is used for the decision makers there is often some translation step where say, a probability distribution gets reduced to a small number of numbers, and then there's some confusion because you know what is a appropriate tool for any future use is not the same as what is the appropriate way of summarizing the available scientific literature and so there's a two step process which probably needs to happen, but might have been better if it were more continuous and iterative the whole time as opposed to a hand-off process. And I think things are going in that direction but definitely a tendency to sort of follow the IPCC model of getting the expert panels and getting them to get their answers and then having other people who use the answers but certainly not consulting with the experts who come up with the original work which interpret them.

Amanda: [00:05:34] Yeah absolutely. And then sort of piggybacking out that you made an interesting point about like you know when people really want to know answers to questions that are hard to ask like what is the sea level going to be an X number of years. And obviously with their projections that we have like it's not always like a very concrete thing.

Bob: [00:05:54] I don't think the problem is that they're not asking a good question. That is a good scientific question, and scientists are good at coming up with estimates and estimating their uncertainty and its limits and limits down the guesswork and certainty. The problem is that they then don't know what to do with the answer to that.

Bob: [00:06:12] They've got the answer to the question they asked, but the question they asked may not be the question they need. Because the question they actually need might be you know ultimately well what strategy do we adopt to reduce our risk of coastal flooding. And the question they asked is what's your estimate of how much sea level is going to rise. So those are clearly related, yet but the answers are not the same. And certainly the obvious simple solution is I can give you the best estimate of sea level rise and if you only plan for that amount of sea level rise there's probably a 50 percent chance that you're going to get flooded.

Bob: [00:06:54] I think that you know, there are a lot of risk trade-offs that really results in requiring an iterative process of risk communication that you know people in and environmental health have been doing a long time but that is somewhat new to the climate area, maybe the last decade or so and I don't think that's been fully sorted out.

Amanda: [00:07:16] So within some estimates that can be hard to pin down, how are you best strategizing communicating variability?

Bob: [00:07:28] So we're going to differentiate between uncertainty and variability, because it can be variable, or it can be slowly changing to varying only following a trend, but the IBM circuit which is you know you look at the decadal or multidecadal have sea levels more these days. So. What I find happens is that scientists of IPCC tend to use language that relates to probabilities, and then sometimes people get confused because they're used to that the say, frequencies, as in how frequently for flooding, but not necessarily probabilities, or, the boundary organisations tend to take the probabilities and use them to guide development of a small number of scenarios that sort of reflect the spread which is a perfectly reasonable thing to do.

Bob: [00:08:32] There's also literature on more sophisticated ways of doing things that by and large I've yet to actually see that in practice. I mean, it seems I think that this approach of you know essentially you select you develop your probability distribution and then you select some probability that you're comfortable with and go with that is a perfectly reasonable thing to do and I think there just is some confusion sometimes about the difference between you know, what is the scientific answer and what is the tool. The scenarios are the tool, not the scientific answer.
Amanda: [00:09:06] OK.
Bob: [00:09:08] So yeah.
Amanda: [00:09:10] Yeah absolutely. Also so we were talking to Tim a little bit and he introduced the SeaRise program which is obviously that new initiative that he's taken on along with you and many other different experts that are involved. So can you speak a little bit today your role within the program and like what sort of your contribution to it
Bob: [00:09:36] Only a little bit because it started them. But basically I'll tell you what I usually do with these groups is we are working on synthesising different lines of information to produce probabilistic estimates of sea level rise.
Bob: [00:09:55] And that's basically I think what I'll be doing with that project. In the U.S. context, I'm increasingly interested in getting beyond that and working to the decision context but you need to be on the ground to do that. So I'm not going to try to develop the stakeholder relationships in New Zealand, that's that's Tim's job. But, you know like with California, I'm going back out there in March and there's sort of an iterative process and I've been talking to some people in San Francisco who don't quite like the way that the government didn't end up using those projections.
Bob: [00:10:36] And so yes. So, the core science we do in this group has to do more with understanding how sea level has changed in the past. But the core applied thing we do is produce sea level rise projections that you know take into account the uncertainty and take into account local factors that cause sea level to differ from place to place and that basically what I'm doing in my job.
Amanda: [00:11:05] Yes absolutely. So also just sort of changing gears a little bit back to your experiences in the States, so what have been your experiences with having conversations about

climate change in terms of the economic effects of it and how the public has reacted to that. How does the public react to conversations about climate change and its economic effects

[00:11:47] The audience I speak to tends to be very interested. In the broader media landscape, there is a least a stratum that seem to be very hungry for this information. You know, our collaboration the climate impact lab has been on the front page of The New York Times multiple times.

Bob: [00:12:08] Yeah our paper that came out last July on county-level economic risk climate change got you know some data reproduced all over the place. So broadly, there are the sort of people who are interested in it and there are some who are not. I honestly haven't had to deal with a lot of those sort of people because of who I work with. They're sort of the current climate skeptics audience and certainly in the U.S.

Amanda: [00:12:42] Yeah absolutely. We're grateful to be doing our current research mainly in New Zealand as it is much more widely accepted. So we've been having a lot more success within those conversations in the public. So yes that's actually all of the questions that we had prepared. Is there anything else that you would like to share, any sort of advice or things that you've learned as you've been communicating your research? Or is that as that's mainly what we're going to be focusing on from now.

Bob: [00:13:16] I mean I think they kind of get on the main points yeah. One person you might want to talk to is David Gardner in San Francisco. He convened with both scientists and stakeholders over the last few months to talk about some of the challenges in the climate change projections. And he has a very interesting perspective

Amanda: [00:13:41] Okay awesome. Thank you very much. Yeah we'll definitely touch them.

Zach: [00:13:45] I actually have one follow up question, before when you talked a little bit about the the intermediate organizations between climate organizations. Can you speak a little bit to like the kind of stuff or how effective they are at and translating the hard scientific data into something that's a little more consumable.

Bob: [00:14:22] Yes and no. I don't think there's enough research on how effective sea level rise projections actually are in moving money around. And I have a project sort of trying to look in to get a couple of students I'm working with who are looking at the decision context in which sea

level rise projections are actually affecting decisions and not just not the plans. Right there are a lot of plans that use sea level rise predictions, but the translation of those plans into on the ground action is limited. So we're looking at that.

Bob: [00:15:29] So that's an interesting research question. I mean one thing I found the more I get into that is a lot of the questions are not the things I'm trained in, but they're social science questions, and that's a lot of the gap

Bob: [00:15:40] So what was your question again.

Zach: [00:15:47] So you mostly answered it, it was mostly just kind of like how effective have your organizations been at translating the data.

Bob: [00:15:55] I mean that's their job, yeah. You know they come up with numbers that get used in the planning process. That is then it's how effective are the plans. OK.

Amanda: [00:16:12] Yes absolutely. So yes I think that's that's all we had. Thank you so much for your time today. Really much appreciated. Thank you.

Zach: [00:16:24] Thank you so much. We really appreciate it.

Amanda: [00:16:27] Yeah. So yeah. Enjoy your day. Thank you very much so much.

Bob: [00:16:33] Bye bye

Appendix P: Summary of Findings from Objective 1-Areas to Target in Future Outreach

Objective 1 Findings	Relevance to Science Communication
SLR preparedness is lower than perceived risk	The public is aware of the risk of SLR but does not know how they can help mitigate SLR. This can cause the public to feel hopeless because they are not able to affect change.
Public has a general but not detailed understanding of SLR	The primary goal in science communication is to create a well educated public. Therefore, there is still more information the public could learn.
Primary sources of information are the internet and TV	The information the public consumes influences their perceptions and knowledge of SLR. Common sources of information are not necessrily vetted for accuracy and can mislead the public.

Appendix Q: Summary of Findings from Objective 2-Best Practices

Objective 2 Best Practices	Explanation
Make information easily consumable	SLR research is complex and technical. The public can only remember information that they understand. Therefore, SLR information must be simple, short, and interesting.
Communicate uncertainty effictively	Uncertainty should be carefully discussed as either variability in data or affected by human actions.
Include positive messaging	Whenever discussing the impacts of SLR, include how the public can take action to respond.
Allow the public to come to their own conclusions	When the public is able to reach their own conclusions they are more likely to internalize it as part of their world view and therefore act on it.
Trust	When the public trusts an information source then they are more likely to accept information that the source provides.